THURSDAY, APRIL 12, 1900.

RECENT BOOKS ON PHYSICS.

A Text-Book of Physics. By W. Watson, A.R.C.S., B.Sc. (London). Pp. xxii + 896. (London: Longmans, Green and Co., 1899.)

Heat for Advanced Students. By Edwin Edser, A.R.C.S., &c. Pp. viii + 470. (London: Macmillan and Co., Ltd., 1899.)

Text-Book of Experimental Physics. By Eugene Lommel. Translated from the German by G. W. Myers, of Urbana, Illinois. Pp. xxi + 664. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1899.)

IT is a pleasure to welcome a general text-book of physics by one of the younger generation of physicists, who has had wide experience in the modern methods of teaching and investigation. Since the general recognition of physics as an experimental science, these methods have changed so much that, although one could not but admire the skill and perseverance shown in re-editing the older text-books and writing them up to date, it was obvious that a great improvement could be effected by making a fresh departure.

In the arrangement of his book, Mr. Watson has adhered in the main to the order of exposition sanctioned by long experience, and has avoided the error, into which some recent writers have fallen, of attempting to revolutionise the basis of physical teaching. The author's guiding principle has been convenience of sequence from the point of view of simplicity and clearness of explanation, and he has thus succeeded in producing a work which the average student may be expected to follow with little or no previous acquaintance with the subject. This is a thoroughly practical basis, and will commend itself to students and teachers alike. As illustrations of this method, we may notice the introduction of a very useful chapter on wave-motion and water waves, with explanations of interference and other phenomena, before the discussion of Sound and Light. In a similar manner, the composition of simple harmonic motions is taken at an early stage as an illustration of periodic motion, instead of being reserved for the section on Sound. A great deal is gained in clearness, and saved in space, by taking difficulties of this kind in detail in their proper place.

Another feature of the book which will commend itself to a large class of students who are compelled to study physics without the aid of the higher mathematics is the elimination of purely mathematical difficulties. Some limitation of this kind is clearly essential in a general text-book, and the author appears to have exercised a nice discrimination in the selection of difficulties to be omitted. By curtailing the mathematics, he has also been enabled to devote more space to the explanation and illustration of purely physical questions, and to include many results of recent research which do not involve mathematical treatment. As an illustration of these points, we may quote the chapters on "Change of State," and on the "Ionisation Theory of Electrolysis," which subjects are treated from a modern standpoint.

In selecting the illustrations for the work, it has been assumed that the student will have access to a laboratory, and will supplement his reading with a practical course of experimental work. For this reason, no attempt has been made to supply elaborate figures of apparatus, or descriptions of details of construction and adjustment which the student can acquire much more effectually by laboratory practice. The illustrations are for the most part of a purely diagrammatic character, and are intended solely to elucidate the text, and not to take the place of the actual apparatus. There is no doubt that the general appearance of the book might be rendered more attractive, and its interest to the general reader, as distinguished from the practical student, would be increased by the insertion of a number of carefully printed and executed woodcuts of instruments and apparatus; but such illustrations belong properly to descriptive and technical treatises, and would be out of place in a text-book. Diagrammatic illustrations are really of much greater educational value when carefully designed, as they can be made to emphasise the essential points of the method or experiment, and are more easily remembered and reproduced than more elaborate pictures. The habitual use of such illustrations also tends to develop the diagrammatic faculty of thinking and working in diagrams, which is so extremely valuable to the experimentalist in designing apparatus or working out a method of research.

We are inclined to think that the utility of the book to the average student would be increased by the adoption of a more distinctive setting for the statement of laws and definitions, and that it would in many cases be desirable to emphasise more categorically the particular points in each law which are capable of definite experimental verification. The majority of students are too ready to accept a formula, and to regard as time wasted any attempt to prove it. They often acquire a fatal facility in dealing with symbols, which may perhaps suffice for examination purposes, but which does not correspond to a real understanding of the subject, and is of little educational value, and readily forgotten. Another addition, which would be of real value to the teacher as well as to the student, would be a carefully selected list of numerical examples, arranged to illustrate the various sections. It would be difficult to make a suitable collection, as nearly all extant text-books are lamentably deficient in this respect; but we are convinced that it would be of great use, and we may hope to see something of the kind in future editions.

In matters of detail a few errata may be noted by the careful reader, but this is natural, if not excusable in the first edition of a new book, and the majority have doubtless been already corrected. A purist might here and there find fault with the turn of an expression, or a specialist in some particular department might criticise some statement or explanation as being incomplete or misleading; but the book as a whole is remarkable for clearness and correctness of exposition, and must be regarded as a valuable and original contribution to our text-books of physics.

The object of Mr. Edser's book is to give a comprehensive account of the science of Heat, both in its theoretical and experimental aspects, so far as this can be done without the use of the calculus. The descriptions of the experiments to be performed by the students are

intended to be sufficient to enable them to secure accurate results. It is remarkable that this combination of the theoretical and the practical is not more often attempted. A book on any branch of experimental physics necessarily contains so much description of experimental work, that the additional instructions necessary to enable the student to carry out the experiments for himself would not add greatly to the length of the book. In a similar manner, a book intended simply for practical work in the laboratory generally and necessarily contains so much theory that it would not be a difficult matter to include all that the student would be likely to require in this respect.

The limitations which the author has imposed upon himself with regard to the use of the calculus apply chiefly to the section on thermodynamics. The method of expansion by the binomial theorem is used instead. The proofs are worked out from first principles, and are therefore generally longer than they would have been if the methods of the calculus had been assumed. But as a compensation they are much more instructive. The method of proof compels a close attention to each detail of the work, which is likely to result in a much clearer grasp of the physical meaning of the equations than the mechanical performance of mathematical rules for differentiation or integration. The student who has failed to follow the purely geometrical treatment of the same subjects in Maxwell's "Theory of Heat," will probably find these sections extremely helpful. They may be also strongly recommended to the mathematical student who does not desire to regard physics merely as a mathematical exercise.

In the selection of the experiments to be performed by the student, the author appears to have erred on the side of making them too simple, and of not exacting a sufficiently high standard of accuracy of the advanced student. He very rightly lays great stress on the importance of accurate thermometry, on which nearly all experiments depend. He might with advantage have given some details of the "variable zero method" of employing mercury thermometers, so ably expounded by Guillaume, which is now so generally used for accurate work. The method is laborious, but possesses undoubted advantages, and ought to be described in an advanced text-book, especially as it does not present any great theoretical difficulties. In determining the expansion of glass by means of the mercury weight thermometer (p. 68), the advanced student should be instructed to use the accurate equation $g=(m-m_g)(W-w)/W$, instead of the approximate equation $g=m-m_g$, which is given in nearly all the text-books. He should not be permitted to make an error of 1·6 per cent. in his calculation, when he may easily obtain observations correct to a tenth of 1 per cent. Similarly, in a text-book for advanced students, it would be more instructive if the author, in introducing a description of some of the old time-honoured experiments, had ventured to be a little more critical of their weak points, and to explain why they failed, or in what respect the deductions made from them were uncertain, or how they could be improved. It seems a pity at the present day, for instance, to repeat Tyndall's fairy tales about the absorption of heat by vapours without adding a large proportion of salt.

A special section is devoted to electrical thermometry, including an explanation of the principles of the methods employed, which is simple and at the same time fairly complete so far as it goes. We may note, however, in passing that a platinum thermometer cannot in general be calibrated by reference to the absolute zero, as the resistance of the pure metal "tends to vanish" at a much higher temperature (*Phil. Mag.* Feb. 1899). Also that if a reasonably sensitive galvanometer is used, the heating effect of the current ought not to exceed a hundredth of a degree. The section contains an account of the thermocouple, thermopile, radio-micrometer and bolometer, which should be useful as well as interesting. In other subjects also, such as the liquefaction of gases, the book appears to be well up to date within the limits which the author has set himself. The whole arrangement is extremely clear and practical, and well adapted to meet the needs of students, who will find the most important points distinctly emphasised. There is a useful summary at the end of each chapter, and an excellent collection of examination questions. Considering its small size, the book contains a remarkable amount of information.

In the preface of Prof. Lommel's "Text-Book" the following explanations occur:—"The present text-book has grown out of the author's lectures, and is intended to develop the subject on an experimental basis in such a manner as to make the book easily accessible to beginners. But in order to meet the needs of higher schools and colleges, paragraphs in 'fine print' are interspersed, which contain the most important mathematical developments in terse and simple form. The author, as a general rule, has employed pure German words rather than technical expressions from foreign tongues, *e.g.* *wucht* instead of energy of motion or kinetic energy, and *spannung* instead of potential and difference of potential. The translator has not preserved the author's distinction between 'potential' and 'tension' (*spannung*), but has otherwise attempted only a faithful and worthy reproduction of the original."

These aims and endeavours on the part of the author and translator appear as a possible explanation of the introduction of several rather unfamiliar terms to English readers, such as "living force" for kinetic energy, "laws of shock" for impact, "stretch" for extension, "melting heat" for heat of fusion, "overmelted" for superfused, and similar phrases. The word "tension" certainly seems to be rather overworked, as it is used for the pressure of gases and vapours, as well as for electric potential, and even in one place for energy of position. On the other hand, we observe the apparently needless introduction of such words as "gyrotrope," "pachytrope," "rheotome," "rheometer" for the more familiar commutators, switches and galvanometers. The frequent use of oxygen for hydrogen, calcium for potassium, and coal for carbon are possibly simple *errata*.

The author has endeavoured to follow the historical order as being the most natural and interesting in the development of each part of the subject. The names and dates introduced in following this plan are often instructive and show a greater familiarity with English work than is common in Continental text-books. We may instance the dates, Boyle 1662, Mariotte 1679. The author neverthe-

less continues, in accordance with foreign usage, to quote he law Boyle discovered as "Mariotte's." He also gives a figure illustrating Cavendish's method of demonstrating the law of the inverse square in electrostatics, but the name of Cavendish is not mentioned, and the figure is labelled "Coulomb's Law."

It is probable that the historical motive is to be held responsible for the retention of many old experiments and figures of archaic apparatus. This is in many cases most desirable and instructive, provided always that the later developments are explained and illustrated so as to point the contrast. The experiments of Wheatstone (1834) on the "velocity of electricity" are of the highest interest and educational value, but it is not fair to leave the student with the conclusion, "Both electricities pass, then, simultaneously from the coatings of the jar, and meet midway between them. The velocity of propagation in a copper wire was found to be 430,000 km. By a different method Siemens (1876) found for the velocity in an iron wire 240,000 km." Again, it is certainly instructive to give a figure of the early type of German mirror galvanometer with a massive four-inch bar magnet inside a rectangular coil, but it is a mistake to ignore the essential improvements introduced by Thomson (Lord Kelvin), and to leave the student with the impression that the instrument figured is the type of a modern sensitive galvanometer. Similarly, in the section on the liquefaction of gases, we have an illustration of Pictet's historical apparatus (1877), and we are informed that "Hydrogen was liquefied at a pressure of 650 atmospheres and a temperature of $-140°$. On opening the tap an opaque stream of liquid of steel-blue colour escaped, at the same time the solidified hydrogen upon the floor produced a rattling sound as of falling shot." It is stated on the previous page that the critical temperature of hydrogen is $-174°$. No later experiments are mentioned. Such omissions as these can hardly be justified even in the most elementary work, and cannot fail to produce the impression that the book is not sufficiently up to date to satisfy the requirements of modern scientific education.

In endeavouring to explain a new term, it is often considered necessary in elementary text-books to put the idea into somewhat vague and general language, rather than in the form of a precise definition, because the more exact statement may fail to convey the idea intended. We are inclined to doubt the wisdom of this course, which appears to be carried too far by the author. The following are a few samples of the kind of statement to which we refer.

P. 24. "*Work.*—When a force acting on a mass sets it in motion, the force is said to do work, and the result of its action is called work." "In transforming forces into work, the question is not alone whether work is done, but also in what time it is accomplished. The work done in one second is called the 'effect' of the force."

P. 289. "*Equilibrium in Conductors.*—When a conductor has attained a condition of electrical equilibrium, the electrical forces, and accordingly also the electrical potential, are everywhere o. This merely says that in a position of equilibrium, every point in and upon a conductor has the same potential."

P. 372. "*Wheatstone's Bridge.*—If the branches *amb* and *anb* of the current are connected by a cross wire *mn*, called a 'bridge,' two currents flow in opposite directions in the bridge. If these currents have equal strength they neutralise each other and no current passes through the bridge. . ."

P. 377.—"Edison's (1879) incandescent lamp depends upon the heating action of the current. A charged filament of hemp, or cotton, of high resistance (*e.g.* 140 ohms) and bent into the form of a horseshoe, is enclosed in an exhausted glass globe to protect the filament from burning, while a current of about 100 volts passing through it heats the filament to incandescence, giving it an intensity of approximately fifteen candles." (Nothing more is said on the subject of incandescent lamps.)

The paragraphs "in fine print" contain the majority of the formulæ, and are intended to meet the needs of higher schools and colleges. They appear, however, to be of too disconnected and occasional a character for the purpose. A good deal of small print, *e.g.* three pages on thunder and lightning, is of very elementary and purely descriptive character. On the other hand, some rather difficult points are discussed in the "coarse print," *e.g.* the "Second proposition of the Mechanical Theory of Heat. Entropy. Kinetic theory of gases." In discussing the Second Law of Thermodynamics and the Dissipation of Energy, no allusion is made to reversible cycles, and the information imparted is necessarily so incomplete that no application could be made of it. Mayer's calculation of the mechanical equivalent is given, but Joule's experimental verification of the assumption upon which it rests is entirely ignored. It may be questioned whether there is any profit in introducing such points if they cannot be adequately discussed. It is not very easy to follow the principle upon which the selection or omission of subjects for discussion is based. The book as a whole does not appear to be sufficiently definite and practical to be suited for class or examination work according to English standards. It is possible that it may be more suited to the methods in vogue in Germany or America.

HUGH L. CALLENDAR.

TWO NEW ZOOLOGICAL HANDBOOKS.

A Manual of Zoology. By the late Prof. T. J. Parker and Prof. W. A. Haswell. Pp. xv + 550. (London: Macmillan and Co., Ltd., 1899.)

An Elementary Course of Practical Zoology. By the late Prof. T. J. Parker and Prof. W. N. Parker. Pp. xii + 608, with 156 Illustrations. (London: Macmillan and Co., Ltd., 1900.)

PROFS. PARKER AND HASWELL have embarked upon a difficult and somewhat ambitious undertaking. To compress an account of practically the whole animal kingdom, with 300 illustrations, into a handbook of 550 pages, intended for beginners, is certainly no light task at the present day. Such manuals were quite possible so long as it was considered sufficient for a book of this kind to deal with the exteriors and the habits of animals, and to consist for the greater part of illustrations of monkeys, beasts and birds, while about one-fifth or less was taken up by reptiles, fishes and insects, with perhaps a figure or two of zoophytes or diatoms from Barbados earth. But

the book before us is nothing if not scientific and modern in its treatment of the subject. It attempts in the first place to do justice to the claims of every one of the principal existing groups of animals, fairly and without favour or prejudice, giving an outline of the structure and morphology of the more important types in each class. In the second place, it introduces the reader to the fundamental conceptions and problems of zoology, such as evolution, classification and phylogeny, distribution in space and time, conjugation, fertilisation, development, and the cell theory. In a work of scope so wide and comprehensive, with at the same time such narrow limits of space, it requires much care and ingenuity to steer a just course between the Scylla of over-condensation and perplexity and the Charybdis of vague incompleteness. The inexperienced reader becomes bewildered, in the first case with excess, and in the second with lack of detail, so that he is at a loss how to sort out, or how to connect, the material which he absorbs. The danger is, therefore, that a treatise of this kind may be used less by the beginner, who requires to be stimulated and interested, than by the more advanced student, who desires merely to "look up" work he has done; in other words, that it may degenerate into a mere cram-book. It must be admitted, however, that if it is possible to succeed in such a task, the authors have done so. The book contains a great store of information, chosen with judgment and set forth with skill. In order to avoid as much as possible the dangers above pointed out, the authors have restricted the extent of ground covered by leaving out some of the less important groups, such as Chimæroids among fishes, by omitting all descriptions of extinct groups, and by dealing only very briefly with embryology. Perhaps the chief value of the work is in its numerous and admirable illustrations, of which the authors had a copious stock to draw upon in the pages of their larger two-volume "Text-Book." Amongst them are some coloured diagrams of the circulation of the blood in various types, for the most part clear enough, but Fig. 204, illustrating the circulation of a fish, certainly requires a good deal of looking at before its meaning can be grasped. The book is intended, we are told, principally for the requirements of the students in higher classes of schools; but is it necessary, even in this educational stratum, to explain the meaning of commensalism by coining and printing such a word as "messmateism," which looks at first like some new form of theosophy? These are, however, but minor points. Judged as a whole, the book is one which fills a distinct gap in zoological literature, and fills it well, as a handy book of reference, though we are inclined to think that the authors have attempted rather too much, and that the class of readers who will benefit most by their work will not be quite those for whose use the book was intended.

The second book mentioned at the head of this notice will be welcomed by many as a handy and inexpensive manual of zoology adapted to the needs of elementary, and especially medical, students, which is at the same time free from the faults and vices of the harmful, unnecessary cram-book. It is written on the same plan as the well-known "Elementary Biology" of Huxley and Martin; that is to say, a certain number of types are selected, and a connected account of each one is given first, after which follow practical directions, necessarily rather brief, for its study and dissection. The examples selected are *Amoeba* and some other unicellular organisms, illustrative of the differences between animals and plants; *Hydra* and *Bougainvillea*; the earthworm, crayfish and pond-mussel; and the amphioxus, dogfish, frog and rabbit. The frog is taken first and dealt with in detail, occupying nearly half the book, as an introduction to biology in its various branches—anatomy, physiology, histology, embryology, classification and various biological problems. Then follow the descriptions of the other types, beginning with the unicellular forms and ending with the vertebrates; and a final chapter deals with the cell and with fertilisation and embryology. The illustrations are numerous and useful, some of them from familiar clichés, others appearing for the first time. The book, it may be safely predicted, will become popular and will run through further editions, in which, doubtless, alterations will be made to keep it up to the level of advances in science. In the present issue, the most recent standpoint of vertebrate embryology is not quite adequately represented. Thus more might have been made of the frequent occurrence of what may be termed the amphioxus stage in the embryonic development of many systems of organs in Craniata, as for instance the appearance, in the development of the vascular system, of a splanchnopleuric subintestinal vein, prior to the formation of the somatopleuric system represented by the cardinal veins, &c., and the origin of the heart itself from the anterior portion of the former system. Again, in the urogenital system the differences between pronephric and mesonephric tubules, both in development and structure, and the homology of the former with the excretory tubules of amphioxus, might at least have been alluded to. The authors do not raise the question as to whether pronephric and mesonephric tubules are to be regarded as homodynamous or not, but leave one rather with the impression that they are; it is surely time now, however, that the English, no less than the German, student (and, for that matter, the English teacher and examiner also) should be told clearly that they are not. The concluding chapter of the book might, in fact, have its interest, as well as its value, increased in many particulars, without adding half a page to its length. But this detracts little from the usefulness of the book as a guide and help to the student and teacher of zoology, and as such it may be confidently recommended.

E. A. M.

THE TEACHING OF METEOROLOGY.

Practical Exercises in Elementary Meteorology. By Robert DeCourcy Ward, Instructor in Climatology in Harvard University. Pp. viii + 195. (Boston, U.S.A.: Ginn and Co., 1899.)

MR. ROBERT D. WARD has written a book for the use of schools and training colleges, which we should think would be very popular with teachers and pupils alike. With the former, because he indicates to them the proper method of giving instruction in meteorology, and, at the same time, supplies so many valuable hints, that he makes their work more profitable, without

increasing the severity of their duties. To the latter, because his object is, among others, to turn the numerous meteorological observations that are made at many high schools to practical account, to clothe the dry bones of mere instrumental readings with an intelligent purpose, and to infuse a new and sustained interest into a mechanical routine. Nothing, we imagine, can be more wearisome than the continual record of temperature and pressure and other data of which no definite use is made. The educational value of such a practice must be very slight, and Mr. Ward has recognised the necessity of improving this mechanical record, and, at the same time, of investing the ordinary class teaching with a definite practical purpose. He has taken both pupils and teachers by the hand in a way that should produce most encouraging results. Doubtless many others have perceived defects in the methods of teaching meteorology, but it is Mr. Ward's merit that he has known how to apply a practical remedy. He, first of all, takes his pupils without instruments, and shows how much can be done by the exercise of ordinary intelligence and trained organised powers of observation. Many a teacher, we imagine, when he sees the numerous questions which Mr. Ward puts, and to which intelligent answers can be given by simple, if acute, observation, will take shame to himself that he has not adopted similar, and even extended, methods for infusing life and interest into the study of a science that is too often regarded as dull and insipid. Here is a specimen, taken at random, of what a pupil is expected to acquire from his own observations.

"Wind and Precipitation. Are any particular wind directions more likely than others to give us rain or snow? Are these the same winds as those which give us the most cloudiness? What winds are they? Has the velocity of the wind any relation to the rain or snow-storm? Does the wind blow harder, before, during, or after the rain or snow? What changes of wind direction have you noted, before, during, or after any storm? Have you noticed these same changes in other storms? Are they so common in our storms that you can make a rule as to these changes?"

None of these questions, it is to be observed, are answered. The answers are to be derived from the student's own notes, which he is shown how to make, and of which he is expected to keep a tabulated record.

Mr. Ward wisely keeps his description of instruments within very moderate bounds; such information is to be found elsewhere, and the object here is rather to induce the student to discover for himself the most important facts in weather conditions, and to proceed to the study of climate and the possibility of weather prediction. With the latter view, means are provided for constructing synoptic weather maps over the area of the United States; and the lessons to be learnt from the study of these maps are brought out by a series of pertinent questions in the manner already illustrated. After familiarity with the construction of weather maps and the method of determining gradients and similar elementary points have been acquired, the pupil is led to the study of the interrelations of the different weather elements, and particularly of the forms, dimensions and movements of cyclones and anti-cyclones, the main features of whose characteristics the pupil is taught to derive for himself from the actual, and not specially prepared, weather maps.

A series of so-called problems in observational meteorology is added, in which the same manner of teaching is preserved. Questions connected with vertical gradients in temperature, with humidity, clouds, &c., carefully graduated according to the student's supposed progress in the study of weather phenomena, are submitted for his consideration, the object being generally to discover the explanation of observed facts. A few useful tables are also given, and in an appendix are some useful hints to teachers, which the author's experience suggests as likely to be of assistance and, at the same time, explanatory of his own purpose. The plan of the book is based on the recommendations in the Report on Geography of the Council of Ten, and is very intelligently pursued. The author shows throughout the earnestness and the capacity of a true teacher, and we hope that his book and his methods of teaching will obtain a wide currency, suggesting as they do a vast improvement on the training generally in vogue. There remains still a further question, which the author does not broach, and on which it is probably preferable to maintain a discreet silence. How far is meteorology perfected as a science to warrant its employment as an educational force, demanding the exactness, and supplying the training, which the older and more recognised means have hitherto supplied?

OUR BOOK SHELF.

Lectures on Some of the Physical Properties of Soil. By Robert Warington, M.A., F.R.S. Pp. xv + 231. (Oxford: Clarendon Press, 1900.)

THIS is a subject of deep interest to the student, and of no small practical importance to the farmer. As Mr. Warington indicates, it is one that has not received a great deal of experimental attention in this country, nor does it usually form a separate subject for class-room treatment. In England we have in the past depended chiefly on the text-books of Fream and Munro, to which may now be added some excellent American manuals, notably that by King. These lectures by Warington form a welcome addition to our literature, and they are worthy of a larger audience than that which surrounded the Sibthorpian chair.

Two of the five chapters are concerned with the relationship of the soil to water. This is a matter which the cultivator—by attention to tillage, cropping and manures—can turn to good practical account. By draining, he can get rid of excessive moisture, while by introducing humus to a dry soil, and by the production and preservation of a fine tilth, he can conserve moisture and place it more fully at the disposal of plants. Farmers and gardeners who read these lectures will learn that there are other ways of providing crops with water than by the use of the water-cart or the watering-pan. In forestry, too, much may be done, by attention to cultural measures, to place an increased supply of water at the disposal of trees, and on these measures the success of woods on dry ground largely depends.

Possibly the chapter that deals with the movement of salts in the soil is the one that will appeal most directly to the farmer. Much of the success of manuring depends on the suitable relationship of fertilisers to soil and climate. Substances that are firmly held by the soil may be used without fear of loss even on light soil and in a district of large rainfall, whereas substances for which soil has but little affinity must be applied with much

discrimination. Other things being equal, sulphate of ammonia is more suitable than nitrate of soda for use in the West of England, whereas the order is reversed in the drier climate of the Eastern districts. The behaviour of soluble plant-food under the influence of heavy rainfall should be considered by farmers in purchasing their supplies of spring manures. The excessive rainfall of the past winter—especially coming, as it did, after a long period of drought—must have very seriously depleted the soil of its natural nitrates, so that increased purchases of active nitrogenous manures for the crops of the current year are clearly indicated.

Let us hope that the reception given to the present volume will induce the author to proceed, without delay, to redeem his provisional promise of a work on the cognate subject of the chemistry of soil. W. S.

Electric Wiring, Fittings, Switches and Lamps. By W. Perren Maycock, M.I.E.E. Pp. xv + 446; with 360 illustrations. (London: Whittaker and Co., 1899.)

Electric Bells and Alarms. By F. E. Powell. Pp. 77; with 51 illustrations. (London: Dawbarn and Ward, Ltd.)

MR. PERREN MAYCOCK, who has already written a number of excellent text-books on electrotechnical subjects, has produced in the present case a book which, while offering no particular attractions to the non-technical reader, undoubtedly serves the purpose for which it is written; namely, to give a thorough idea of present practice in the electric lighting of buildings. The book is the more welcome since the widespread introduction of 200 and 220 volt lamps during the last three years has rendered all books dealing with electric-light fittings written previous to that time seriously out of date. It is not merely the perfecting of the 200 volt lamp which has rendered this change possible. The design of lamp-sockets, switches and fuses has been of late much improved. The fewness of parts, the simplicity of construction, and the ease and security of wiring of the modern lamp-socket are in striking contrast to the older fittings. These improvements, though apparently trivial, are none the less important.

Another change of the last few years has been the gradual displacement for all but street lighting of the open arc by the enclosed arc lamp, with its greatly lengthened arc and its increased electromotive force and reduced current. Mr. Maycock's passing description of the Nernst lamp reminds one that that most promising novelty has not yet made its *début* as a commercial article.

The illustrations to the text are numerous, and the sectional drawings on the whole very clear. The practice of taking illustrations largely from manufacturers' trade-lists, which is usually to be deplored, is in the present case justified. In no other way could the fittings at present available be properly described. We recommend Mr. Maycock's book as the best we have seen on the subject.

Mr. Powell's unpretentious little book or pamphlet on electric bells and alarms forms No. 3 of the "Model Engineer" series. It furnishes the reader with an attractive and satisfactory account of the various forms of a most useful, if humble, piece of electrical apparatus. D. K. M.

Report of the Marine Biologist for the Year 1898. *Cape of Good Hope Department of Agriculture.* Pp. v+ 362. (Cape Town: Richards, 1899.)

THE Cape Government is to be congratulated upon the success which has attended its efforts to investigate the sea-fisheries of the Colony. Dr. Gilchrist, the marine biologist who was appointed to inquire into the best means of developing the fisheries, was undoubtedly well advised in securing, at the very commencement of his undertaking, a properly equipped steam fishing vessel of sufficient size and power to safely keep the sea, and the results recorded in the present report justify, in a manner almost beyond what could have been anticipated, the expense which the purchase and up-keep of such a vessel has entailed. It has been clearly shown that the seas around the Cape of Good Hope contain a vast source of unexploited wealth, the development of which would provide a valuable and healthy addition to the food-supply of the people. So far as can be gathered from the report, the only difficulty to be contended with is that of getting the fish to the centres of population in a fresh condition. With a climate such as that of Cape Colony it would seem that the best means of overcoming this difficulty is by the use of refrigerating chambers both on the fishing-vessels themselves and on the trains used for transporting the fish by land.

The present report does not attempt to deal with the more scientific aspects of fishery investigation, although there is evidence that this side of the question is not being altogether neglected. It is of the greatest importance that the newly discovered fishing-grounds should be very thoroughly investigated at the present juncture, before much fishing has taken place upon them, and this investigation should deal, not only with the fish population, but quite as thoroughly with the lower forms of life, which are the food of the fishes. Such an investigation will be invaluable in after years, as it will make it possible to ascertain exactly what influence constant fishing has produced, and many evils which have arisen in the European fisheries may be avoided. It is greatly to be desired that the Government of the Cape of Good Hope will show themselves sufficiently enlightened to realise the immense value of accurate scientific investigations at the present time, and the unique opportunity which they now possess—an opportunitg which will probably never return—of developing their fisheries upon sound and scientific principles, based upon a trustworthy record of facts. E. J. ALLEN.

Science Course for Secondary Schools. By G. Robb and J. Mirguet. In Three Parts. I. "Practical Physics," pp. 167; II. "Notions of Physics," pp. 247; III. "Practical Chemistry," pp. 182. (Cairo: National Printing Office, 1898–99.)

THESE three small volumes have been specially compiled to meet the requirements of the Science Syllabus prescribed by the Ministry of Public Instruction to be used in the Secondary Schools under the management of the Egyptian Government.

Part i., "Practical Physics," consists of a series of experiments illustrative of the initial phenomena to be observed by the elementary pupil during his first year. The plan adopted is to first describe an experiment, and afterwards enunciate the law to be associated with it. The first five chapters deal with measurements of length, area, volume, force and weight, succeeding chapters being devoted to density, composition of forces, centre of gravity and equilibrium, properties of matter, elementary hydrostatics and theory of gases. The text is sufficiently ample for clearness without being so detailed as to take the place of a text-book.

Part ii., "Notions of Physics," is in effect a text-book for the assistance of second year pupils in following the series of demonstrations given by the teacher, which constitute the whole of the second year's course. If, as the author's statement appears to indicate, it is a fact that for a complete year the students simply attend a course of experimental lectures without doing *any* practical work themselves, this would hardly, according to modern views, be consistent with the pupils obtaining the maximum advantage from their instruction. The opening chapters deal with the phenomena connected

with motion, gravitation, inertia and energy, all units measurements and numerical examples being expressed in the metric system. Following these are sections treating of the elementary phenomena of heat, light and electricity. Magnetism, however, strangely enough, appears to have been entirely neglected, but no statement is made in explanation of this somewhat unusual omission. The arrangement and style of both text and illustrations are very good, the only objectionable feature being the ambiguity of a few of the mathematical signs, this being probably explained by the statement of the author that French types were used in this book. Some 240 illustrations add considerably to the utility of the volume.

Part iii., "Practical Chemistry," presents, in the form of a number of described experiments, the mode of preparation and properties of the more common elements and simple compounds. In addition to the actual descriptions of these bodies, much correlative matter is also included as to their distribution and economic use. A noticeable omission, from the reader's point of view, is the fact that no equations representing the preparations and reactions of the various substances are given in the text. A collection of equations is, however, given in an appendix at the end of the volume, but it is specially mentioned that the matter contained in this appendix is beyond the scope of the examination. Seeing that this is the third year of the pupil's training, and considering the important manner in which chemical equations enable a student to more easily understand the nature of a reaction by showing at a glance how the several constituents of a mixture arrange themselves, it is difficult to agree with such an omission. The experiments themselves are well chosen, and are usefully illustrated by numerous cuts of the apparatus in position. Each substance is discussed under the headings:—(1) Preparation; (2) Physical properties; (3) Chemical properties; (4) Occurrence and Uses.

L'Échappement dans les Machines à vapeur. By G. Leloutre. Pp. 156. (Paris: Gauthier-Villars. Masson and Co., 1900)

Produits aromatiques; artificiels et naturels. By Dr. G. F. Jaubert. Pp. 169. (Same publishers.)

THESE two volumes are the latest additions to the comprehensive series published as the Encyclopédie scientifique des Aide-Mémoire. M. Leloutre has for many years carried on experimental and analytical researches upon steam engines, with particular reference to the condition of the steam in a cylinder during compression and exhaustion, and under different conditions. In the present volume he extends the results arrived at in his "Théorie générale de la machine à vapeur," and adds to his fundamental equations for the analysis of the trial of a steam engine a sixth term depending upon the condition of the steam in the cylinder at the end of the exhaust.

The natural and artificial aromatic substances at present known are tabulated by Dr. Jaubert. They are arranged in five classes, namely, aromatic alcohols; aromatic acids; terpenes; camphors; alcohols, aldehydes and terpene acids. A short description is given of the characteristics of each class, and following it are tables showing the commercial name, scientific name, empirical and constitutional formulæ, method of preparation, references to literature, properties and characteristic reactions. The study of these compounds is now the most important branch of organic chemistry, not only from the point of view of pure science, but also on account of their commercial value. The book should therefore be found of service to both chemists and pharmacists, as a convenient work of reference.

Grundzuge der geographisch-morphologischen Methode der Pflanzensystematik. By Dr. R. von Wettstein. Pp. 64. Mit 7 lith. Karten und 4 Abbildungen im text. (Jena: Gustav Fischer, 1898.)

THIS suggestive little work, coming as it does from the pen of Prof. von Wettstein, will be read with attention by all who are interested in the wider problems of systematic botany. The author contends that a separation of species or sub-species on morphological grounds alone is unsatisfactory, and he reminds his readers that the appreciation of differences by this method must be ultimately a purely subjective one, and that the conclusions arrived at are liable to be vitiated on several grounds. Von Wettstein pleads for a more general recognition of the geographical areas occupied by species, and considers that a careful study of these will eliminate errors due to modifications depending on climatical or other physical conditions; and it is well known how efficient these are in producing races which, though retaining a general resemblance to a common ancestor, may yet be greatly dissimilar amongst themselves.

He applies his methods to a study of the Endotricha-series of Gentians, and thus comes to reduce the twenty-two species to six ground-forms or genuine species.

He further discusses some of the Euphrasias, and arrives at a corresponding result. It may, however, be urged that this method also is open to objection, and that more is to be got out of the study of species by experimental cultivation—an arduous task, but one which will perhaps yield more fruitful results than even the application of the geographical-morphological method.

Dreams of a Spirit-Seer, illustrated by Dreams of Metaphysics. By Immanuel Kant. Translated by E. F. Goerwitz, and edited with an introduction and notes by Frank Sewall. Pp. xiv + 162. (London: Swan, Sonnenschein and Co., Ltd., 1900.)

THE chief object in publishing this translation of Kant's "Traüme," which first appeared in 1766, is to show the relation between the philosophy of Kant and the teachings of Swedenborg. Students of metaphysics and psychology will appreciate this aid to a study of Kant's philosophical development.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Process of Dyeing with Woad Alone.

IN my paper in NATURE (February 1, 1900, p. 331) on the blue colour in woad, no account is given of the method by which prepared woad can be used for dyeing wool blue. Some of my friends have suggested that the above-named communication was, in consequence, like the play of *Hamlet* with the Prince of Denmark left out. The request for information then made as to the *modus operandi* of the mediæval dyers who used woad and woad alone for dyeing blue has up to the present yielded no response.

There exists a tendency to believe that by long-continued cultivation the woad now grown and prepared in this country has lost its power of dyeing blue, and is only of use in setting up fermentation in the indigo vat. It is, however, very improbable that a plant like *Isatis tinctoria* should entirely lose so characteristic a property as that of indigo-formation. It was, however, possible that some variation in the details of its manufacture might have had this effect. That fresh woad still can be made to yield indigo was shown, and the process of extracting it given in detail, in the paper above referred to.

Prepared woad is a dark brown, earthy-looking paste having an ammoniacal odour, yielding a yellowish-brown solution to water, and looking as unlikely a source of a blue dye as could

well be imagined. A supply having been obtained from the Parson Drove Mill, a series of attempts were made in flasks and beakers to get the blue colour, but they all proved unsuccessful. It was then determined to experiment on a larger scale. Having secured the assistance of a colleague, Mr. C. G. Barrett, we started an eight gallon vat in a small barrel, in a steam laundry. The directions of Hellot were closely followed—woad, weld, bran, madder, lime and hot water were duly mixed, the vat carefully covered, and periodically stirred—the result being, not a little to my surprise, that at the end of twelve hours a skein of wool, after an hour's immersion in the filthy-looking liquor, turned a good "pastel blue" on exposure to the air. A number of experiments were then made on a smaller scale, which we found answered equally well, and proved that it is as easy to dye wool blue with our English woad to-day as it was 300 years ago; any housewife could do it now, if need be, as easily as then. It is simply a question of digesting the woad at a temperature of from 100° to 140° F. (40° to 60° C.) for a prolonged period. We found half a pound of woad (500 grammes) to a gallon (4 litres) of water quite enough to yield good results. The water should be poured on the woad nearly boiling, the vessel closely covered at first, and kept heated to the above temperature. This can very conveniently be done by placing it on the brickwork of a steam boiler. In from ten to twelve hours small bubbles will begin to appear on the surface of the liquor; a little recently slaked lime (6 or 7 grammes) should now be stirred in, one noticeable effect of which will be the generation of an ammoniacal odour. A small pattern of wool left in for an hour will become pale blue on exposure to the air. In the course of a few hours a gramme or so of bran will set the fermentation up again, which in its turn can be controlled by adding lime. In this way the process may be kept going on for several days.

The longer and more often the patterns are immersed the darker they become—at first pale blue, they will eventually become dark blue—almost black. The paler shades are apt to have a green tint, and it was "to kill the green" that the older books on dyeing recommend the addition of a small quantity of madder.

It must be remembered that the quantity of indigo in woad is but small, so that experiments with less than half a pound are not likely to be successful; the great point, however, is keeping the temperature about 100° to 120° F. for many hours.

Our ancestors had neither steam boilers nor thermometers, but they would be able to keep the contents of an earthen vessel "nicely warm," as judged by the hand, by placing it on the hearth, when the embers were kept alight all night, for in those times kindling a fire by flint and steel was always an undertaking.

My thanks are due to Mr. C. G. Barrett for his great help in conducting these experiments, and for the facilities he has afforded for carrying them out, as well as to Mr. Fitzalan Howard, Prof. Penzig, of Genoa, and Sir Thomas Wardle.

King's Lynn, March 31. CHARLES B. PLOWRIGHT.

Illogicality concerning Ghosts.

MR. HERBERT SPENCER, exposing the various inconsistencies that occur so frequently in the ghost-stories of the savage races, says:—"How illogicalities so extreme are possible, we shall the more easily see on recalling certain of our own illogicalities. Instance . . . that familiar absurdity fallen into by believers in ghosts, who, admitting that ghosts are seen clothed, admit, by implication, that coats have ghosts—an implication they had not perceived" ("The Principles of Sociology," 3rd edition, vol. i. p. 104). It seems interesting to note that the same opinion was expressed about nineteen centuries ago by the Chinese philosopher, Wang Chung (*circa*, 27–97 A.D.), whose sceptic remarks on the traditions of all manners, handed down to his time in the Middle Kingdom, form a celebrated work named "Lun Han" or "Balance of Discussions." In its twentieth book (fol. 14–15 in Miura's edition, Kyôto, 1748), he says:—"Since the beginning of the world, so vast has been the number of the deceased, that it enormously exceeds that of the whole present population. Therefore, should every one become a ghost after death, man is bound now to meet a ghost at each step on the road, and should he see ghosts in his dying moments, he ought to find not one or two singly, but several millions of them collectively filling the space. When a man dies by a weapon, his blood, the essence of his life, turns to what is termed *ignus-fatuus*, which has no resemblance to him, but gathering itself into an amorphous mass, looks like the light of fire. It is the ghost of blood, and presents an aspect quite different from a live man's blood, and, as the essence of life has been separated from the man's body, it cannot resume his shape in life. If all ghosts be seen in the form of dead corpses, you have reason to suspect the dead to become the ghost. . . . And, equally, a disordered fellow might be true in seeing a ghost of his live friend visiting him. But how could he see a dead man in his shape of lifetime? . . . . As warm ashes, even after the fire has gone out, can be made to produce it again, we may with some reason suggest the possibility of a dead man appearing in the same form as alive. When we know well, however, that a fire once extinguished can never burn anew, it is evident that a dead man can never become a ghost. And now, what is the ghost? All say it is the soul of a deceased. *Then, even if it could be seen by man, it ought to appear stark naked and fully disrobed: for the clothes have no soul to cover the dead man's soul; while the latter has no material body to put on a material raiment.* Soul is an outcome of blood and breath, which, though dependent on body during man's life, are the things distinct from it; hence it might be still well to suppose soul able to survive body as a ghost. But the clothes consist of nothing but threads, cotton, hemp and silk, which have all no intercurrence of blood and breath imparted by the wearer's body; nor do they possess any blood and breath of their own; so that even when they keep their form entirely, they are as soulless as a human corpse; and how then could they resume their former shape after their total decomposition? Thus, saying that a ghost appears clad necessitates the admission of its possession of body; which view itself militates against the definition of the ghost, because, according to this statement, the said ghost is a composite of the ghosts of body and clothes, which is essentially different from the soul of a deceased individual."

It is curious to observe that Wang Chung himself is quite illogical in esteeming it just to suppose a ghost able to appear only divested: for, according to his own proposition, the soul exists only in blood and breath; while the body, though very closely connected with them during life, is, after death, as severed from them as the ever lifeless and soulless clothes; so that, should it be necessary for a ghost to appear divested, it would be equally so to appear disembodied at the same time.

April 2. KUMAGUSU MINAKATA.

Fertilisation of Flowers in New Zealand.

ON p. 16 of your issue of November 2, 1899, reference is made to an article in the London *Quarterly Review*, by "A Field Naturalist," in which the writer expresses the opinion that "under natural and equal conditions, self-fertilisation of flowers is both the legitimate fertilisation and the most productive." I have not seen the article, but would like to place on record the following facts, which may be of interest to botanists in this connection.

I have cultivated most of the common flowers of the European and North Temperate region during the last thirty years, and have kept a pretty close record of their behaviour under the somewhat altered conditions in which they are placed in New Zealand. In this part of the colony the climatic conditions are not very dissimilar to those of the milder and moister parts of Britain, but the insects are, of course, totally different.

Previous to 1885, when humble-bees were first introduced into New Zealand, certain flowers, which were freely cultivated here, never produced seeds under natural conditions. But since the bees have become numerous and have spread over the colony, the conditions have quite changed. Primroses, cowslips, and the various hardy hybrid primulas all seed freely. So do pansies, crocuses (except the common yellow Dutch, which does not seem to be fertilised by the bees), Canterbury bells, antirrhinums, and many others which formerly never seeded. Now we find the plants in the spring-time surrounded by crowds of self-sown seedlings.

The bees were introduced, as is well known, by the Canterbury Acclimatisation Society, for the purpose of fertilising the flowers of the common red clover—*Trifolium pratense*. It was supposed at the time, that the insect which was introduced was *Bombus terrestris*, which, by the way, is unable to fertilise the flowers of red clover on account of the shortness of the trunk. As a matter of fact, some of the nests brought out to the colony were those of *B. terrestris*, but among them were also two varieties of *B. hortorum*, and it is this latter long-trunked species which is now so abundant, and fertilises so many of the introduced flowers.

In spite of the fact that primroses and other flowers are now enabled to produce seed by the agency of the bees, attempts to introduce them into the woodlands and open spaces and to get them to go wild there are still quite unsuccessful. Certain grasses, particularly cocksfoot, *Poa annua* and *Poa pratensis*, are too aggressive, and choke out nearly all other small vegetation. GEO. M. THOMSON.

Dunedin, N.Z., February 16.

JUBILEE OF THE ROYAL METEOROLOGICAL SOCIETY.

THE Royal Meteorological Society attained its Jubilee on Tuesday, April 3, having been founded on April 3, 1850; and this fiftieth anniversary was celebrated by the holding of a commemoration meeting, a conversazione, and a dinner.

The commemoration meeting was held at the Institution of Civil Engineers, in the afternoon of the 3rd inst., and was numerously attended. The following delegates from other societies had been appointed, most of whom were present, viz., the Royal Society, Prof. J. J. Thomson, F.R.S.; Royal Astronomical Society, Mr. E. B. Knobel, President; Royal Geographical Society, General Sir Henry W. Norman, G.C.B., G.C.M.G., C.I.E.; Geological Society, Mr. J. J. H. Teall, F.R.S., President; Institution of Electrical Engineers, Prof. Silvanus P. Thompson, F.R.S., President; Royal Agricultural Society, Sir Ernest Clarke, Secretary; Royal Horticultural Society, Sir Trevor Lawrence, Bart., President; Royal Botanic Society, Major J. W. N. Cotton; Scottish Meteorological Society, Mr. R. C. Mossman; Sanitary Institute, Mr. A. Wynter Blyth; Hertfordshire Natural History Society, Mr. J. Hopkinson; and Oxfordshire Natural History Society, Mr. H. Balfour, President. The German Meteorological Society sent, as their delegate, Prof. Dr. G. Hellmann.

The Secretary, having read a number of letters and telegrams, the President, Dr. C. Theodore Williams, expressed his great pleasure and satisfaction in receiving good wishes and congratulations from so many friends, and especially from foreign meteorologists and meteorological societies. He then read the address which the late Mr. G. J. Symons, F.R.S., had prepared for the occasion, and added some remarks of his own in appreciation of Mr. Symons, and also on the work of the Society.

The earliest English meteorological observer and recorder, of whom the work has come down to the present day, was the Rev. William Merle, whose record of observations for the seven years 1337–1344 is still preserved in the Bodleian Library at Oxford. The earliest English book on the weather was issued about 1530, the title being "Godfridus: Here begynneth The Boke of Knowledge of Thynges Vnknowen apperteynynge to Astronomye, with certayne necessary Rules," &c. Among the early meteorological authors and observers, Mr. Symons mentioned the Rev. Dr. John Goad, 1686; the Hon. Robert Boyle, 1659; Dr. Robert Plot, 1683; and Sir Christopher Wren, 1697.

The first English Meteorological Society was founded in 1823, on the suggestion of Mr. J. G. Tatem, but it only survived for a few years. A second Society was started in 1836 by Mr. W. H. White, which continued in existence for some years, and included among its members the late John Ruskin. The present Society was founded on April 3, 1850, by Mr. James Glaisher, F.R.S., with the co-operation of Dr. J. Lee, F.R.S., and several others. This was called "The British Meteorological Society" until 1866, when a Royal Charter of Incorporation was obtained, and the name was changed to "The Meteorological Society." In 1882 Her Majesty the Queen accorded the Society permission to adopt the prefix "Royal." For many years the Society had no habitation; but in 1872 a room was engaged at 30 Great George Street, Westminster, and an assistant secretary appointed. Since that time great progress had been made, the work of the Society had greatly increased, and a large and valuable library had been got together. The offices now comprise a suite of rooms at 70 Victoria Street. Both Mr. Symons and Dr. Williams referred, in some detail, to the work which had been done by the Society, and to the investigations which were still in progress.

Congratulatory addresses were delivered by Prof. J. J. Thomson, F.R.S., Mr. E. B. Knobel, Mr. J. J. H. Teall, F.R.S., Mr. R. C. Mossman and Mr. A. Wynter Blyth. Dr. G. Hellmann handed to the President an address from the German Meteorological Society, and also spoke of the valuable work accomplished by the Royal Meteorological Society. The President then presented to the delegates a commemoration medal which had been struck for the occasion.

A conversazione was held in the evening at the Royal Institute of Painters in Water-Colours, Piccadilly. In addition to the music provided by the Royal Artillery String Band and by the "Schartau" Part-Singers, an exhibition of meteorological instruments, &c., was arranged in an adjoining room. This included many interesting and historic instruments, among which were some used by Dr. Livingstone in his travels through Africa, and the aneroid barometer used by Mr. Glaisher and Mr. Coxwell in their famous balloon ascent from Wolverhampton on September 5, 1862, when they attained an altitude of seven miles from the earth. During the evening lantern demonstrations were given (1) by Mr. T. C. Porter (of Eton), showing the growth of eclipse of the shadow of the Peak of Teneriffe by the shadow of the earth; (2) by Colonel H. M. Saunders on clouds; and (3) by Mr. W. Marriott, on meteorological phenomena and portraits of presidents of the Royal Meteorological Society.

On Wednesday morning, the 4th inst., a large number of the Fellows went down to Greenwich, and were, by permission of the Astronomer Royal, shown over the Royal Observatory. In the afternoon a visit was paid to the Painted Hall and the Naval Museum.

In the evening a dinner was held at the Westminster Palace Hotel, under the presidency of Dr. C. Theodore Williams. General Sir Henry W. Norman, in responding for the Army, stated that as senior officer he had taken Lord Roberts under fire for the first time. He also brought a message from the Royal Geographical Society congratulating the sister society on the attainment of its jubilee. Mr. W. N. Shaw, F.R.S., in proposing the toast of the evening, said that the history of the Royal Meteorological Society was fifty years of development and co-operation in meteorological research—a development which had taken place chiefly in the direction of combining the observations of many persons in different parts of the country for the single purpose of advancing our knowledge of atmospheric phenomena. Dr. Williams, the President, replied. In replying for "The Delegates from other Societies," Prof. Silvanus Thompson, F.R.S., spoke of the contact of electricity with meteorology, and pointed out how that science had keenly interested many of the inquirers into magnetic and electrical matters, from Boyle to Lord Kelvin, for it was impossible for a man to work at physics generally without coming across the physics of the earth, the atmosphere and the sea. Speaking of the interference caused to magnetic and meteorological observations by leakage from electric-light and traction systems, he said such leakage was quite unnecessary. It arose from the adoption of methods that had, perhaps, been adopted without due consideration, and it was possible to propel electrical tram-cars without corrosion of gas and water-pipes, and without disastrous consequences to meteorological and magnetic observations.

PROGRESS IN NORTH-WESTERN AMERICA.[1]

THIS book, excellent of its kind, is primarily intended for the sportsman, though possessing also a wider interest. Two-thirds of its contents and the majority of its illustrations are devoted to the description of those forms of the animal life of Western America which men most eagerly kill for pleasure or profit. The wapiti, the "antelope-goat," the moose, caribou and deer, the bighorn, the prong-buck, the bears and the bison, are all in turn discussed, generally with vivid personal reminiscences of their pursuit and slaughter amid their natural surroundings. Interesting chapters are also written on the seal and other fur-bearing animals of the Pacific Coast, and on the salmon of the British Columbian rivers; and four of the later chapters of the book (pp. 225–315) contain an account of the author's experiences as a pioneer in the Kootenay district of British Columbia. In the opening up of this district Mr. Baillie-Grohman played a conspicuous part, and in view of the rapid development which it has undergone during the last ten years, some permanent historic interest will no doubt attach to this account.

The reckless waste which has accompanied the inrush of civilised man upon the wild lands of Western America must have struck every observant traveller. The prairies robbed in a few years of their slowly accumulated fertility; the grazing lands of the dry region overstocked and ruined; the ancient forests among the mountains destroyed wholesale by fire; the mineral deposits hastily and carelessly ransacked—in every quarter is shown the same hurry to grasp an immediate advantage without the slightest regard for the future. But it is upon the indigenous animals that the destructive propensities of these modern times have fallen with direst effect, driving harmful and harmless species alike towards the irrevocable doom of extinction.

Even while we may acknowledge that the past history of life on the earth is one long record of extinction of life-forms, and that the spread of mankind must almost inevitably bring about the destruction of all the larger animals not directly serviceable to him, the process is none the less grievous to contemplate, especially when, as in this case, it is carried on wantonly and inexcusably in advance of the needs of the community.

Like many another sportsman, Mr. Baillie-Grohman laments the havoc wrought by others, while indirectly taking credit to himself for his own moderation and "scientific" methods. But in reading his book we fail to find cause for exonerating him from the stigma of having aided in the unnecessary slaughter of some of the most characteristic, most beautiful and most harmless animals of the continent. It is true that to some extent he selected his game, and did not kill indiscriminately; but in reading his pages we are impressed again and again with the lack of any adequate reason for the great aggregate destruction he chronicles. He remarks:—

"Trophies of the chase can be regarded from two different points of view—*i.e.* from that of the naturalist, as more or less valuable contributions to our knowledge of natural history; and, secondly, from a purely sporting point of view. To the scientific investigator desirous of establishing the length, the widest spread or the greatest circumference of the 'largest on record' of some particular species, it is naturally a matter of indifference who killed the bearer of the trophy deserving that distinction. To the sportsman, on the other hand, who disdains to adorn his walls with spoils that he has not obtained himself, it is a matter of interest what other fellow sportsmen have shot, while the fact that some skin hunter

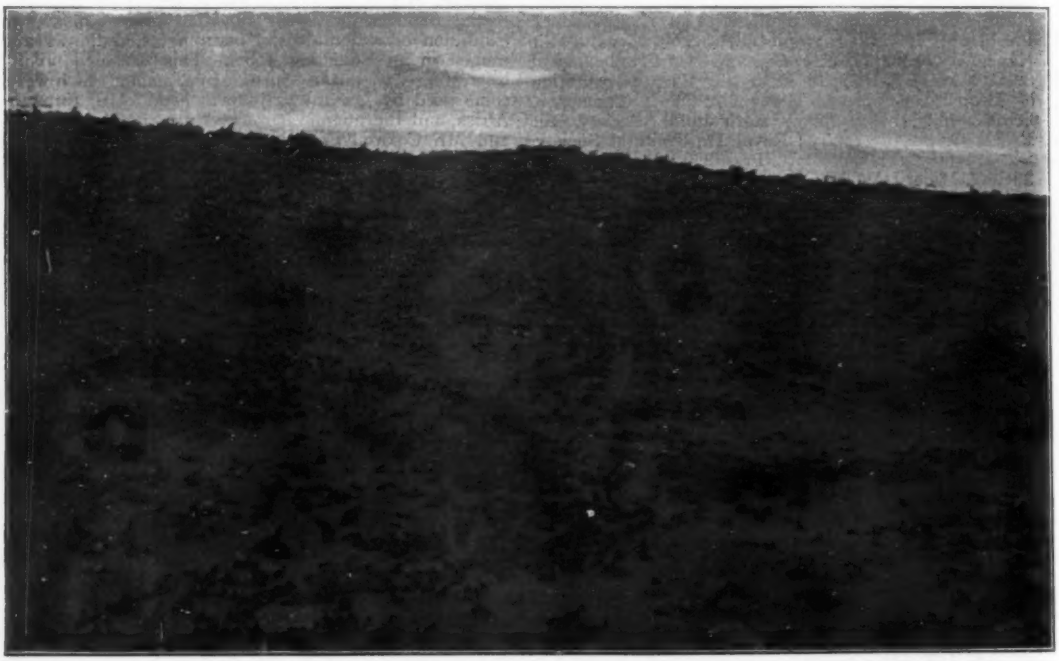

FIG. 1.—Fur Seal Rookery on the Pribiloff Islands.

[1] "Fifteen Years' Sport and Life in the Hunting Grounds of Western America and British Columbia." By W. A. Baillie-Grohman; with a chapter by Mrs. Baillie-Grohman. Illustrated by 77 photographs, including the best trophies of North American Big Game killed by English and American Sportsmen &c. Pp. 403. 8vo. (London: Horace Cox, 1899.)

of Wyoming or Montana has bagged a wapiti with antlers, or a bighorn with horns an inch or two larger than the best of his own killing, remains a matter of indifference" (p. 43).

But the "scientific investigator" need not have been dragged into the argument; it is "a matter of indifference" to him also that an individual of a species already thoroughly studied should in some minor characteristic exceed its fellows by an inch or two, and it is not in *his* interests that the indiscriminate collecting of "trophies" can be justified.

In commenting on the abortive attempts which have been made, both in British Columbia and the United States, to arrest the destruction by the enactment of game-laws, Mr. Baillie-Grohman has some pertinent remarks. He says:—

"To have to acknowledge that the destruction of big game there" (*i.e.* in the hunting grounds of the Rockies) "was the work of one single generation is not a pleasant truth for the 'Makers of the West.' Until the completion of the first trans-continental railway, thirty years ago, the muzzle-loaders of white men had made no serious impression upon bison and wapiti, upon bighorn and deer. . . . Unjustifiable as the rapid extinction of the red man will appear to our grandchildren, the extermination of the animals that dwelt on his plains, that roamed his forests, or that filled his rivers, must seem even less excusable, for, in their case, protection should have been as possible as is in civilised communities the enforcement of laws protecting human life. But the frontiersman, . . . in his fierce and utterly selfish attack upon nature, waged a merciless war, the like of which no country has ever seen, for in days of older conquests the scientific means of wreaking destruction in such a wholesale manner were lacking. The finely-sighted Sharp breech-loader, with which he rolled over in one 'stand' as many as forty or fifty bison in as many minutes, . . . is as much an invention of our time as is the giant powder (dynamite) cartridge, with which he kills by one explosion literally hundreds of salmon and trout in a single deep pool. A vastly increased network of railways assists him in reaching hunting grounds. . . . Even the telegraph wire . . . was pressed into service. . . . The same merciless war against nature was waged by the miner and prospector; the one, by depositing vast masses of worthless 'tailings' and rock *débris* into fertile valleys . . .; or by setting fire to the forests in spots likely to contain mineral wealth. Thus were denuded by conflagrations, which the writer has known to last in the Kootenay country and along Puget Sound from May to October, thousands and tens of thousands of square miles of country covered with the most superb woods to be seen in any part of the world" (pp. 28–30). . . .

"And what about the game-laws? . . . The laws, and sufficiently good laws, were there all right enough on paper, and, what is more, they had been framed at a sufficiently early date to have saved the bulk of the game, only there was nobody to enforce them. That was the crux of the whole question" (p. 33).

But in reading Mr. Grohman's eloquent denunciations, one cannot help feeling that it is his sense of the slaughter having been done by the wrong persons and in the wrong manner that has aroused his anger, and not the mere fact that the animals have perished. It seems to be implied that such game should have been reserved for "sportsmen," and not have fallen to the despised "hide-hunters" and "meat-hunters." Yet it is these latter, after all, who could give the better practical excuse for the mischief they have done.

The incongruity of the author's attitude is curiously exemplified in the latter part of the chapter (ii.) above-quoted, where he mentions the "pettifogging meanness" of the British Columbian game-laws and the "absurd jealousy of English sportsmen," and especially where he undertakes to give "a few practical hints concerning the working of the game-laws of the Western States." After a brief reference to the wide privileges of a settler, who can kill game for his own use practically at any season of the year, we read:—

"What is the use, one may well ask, of the Montana law limiting a stranger to two wapiti so long as there are no officials to see that this number is not exceeded? In a country where in the wilder parts you can still travel and hunt for weeks without seeing a human being, it would require an army far larger than that of the whole United States to enforce such regulations. And even were such an army available, the investment of 50*l.* in a 'ranch' makes the stranger a 'settler' in the eyes of the law.

FIG. 2.—Salmon leaping an 18 ft. high fall on White Bear River, Labrador.

"*In one respect care has to be exercised: it is concerning the trophies. These should not be brought to the railway stations in numbers exceeding the law's limit, for blackmailers, prompted by the reward in the shape of half the fine, have of late years more than once caused English as well as American shooting parties considerable trouble and expense. The task of transporting the trophies out to the railway should be left to your hunter or guide to accomplish after you have left. If he is worth his salt, he will manage to get eight or ten picked heads to the railway and dispatch them, packed in cases, without any trouble*" (p. 42, original not in italics).

Now how can the author—no doubt a staunch upholder of our own game-laws—defend this incitement to lawlessness? All game-laws must be essentially arbitrary conventions, and can only be supported on a conventional basis; and if it be a crime to break such laws in our own country, it is equally a crime to break them across the Atlantic. Is, then, the risk of detection to be the only deterrent in these matters, and is the man to be called a blackmailer on the other

side of the water who would be called a gamekeeper at home?

While we may regret the manner in which the author has gained his information, we may concede that he has written an interesting account of the animals he has hunted, though always from the standpoint of a sportsman. Of these the wapiti (*Cervus canadense*), the antelope-goat (*Haplocerus montanus*) and the bighorn (*Ovis montana*) appear to have constituted his favourite prey, and are consequently most fully described and illustrated.

In the chapter on seals, Mr. Grohman condemns pelagic hunting in unmeasured terms:—

"Pelagic sealing is a cruel and most wasteful method of obtaining peltry which can be secured by 'land killing' at the rookeries without inflicting suffering and without any appreciable waste. Those who dispute this do so either from ignorance of the true facts or from interested motives" (p. 192).

Regarding the salmon of the Pacific Slope, he has the same black record to make of reckless waste and rapidly diminishing resources, stating, on the authority of a Canadian Blue Book, that at one of the Alaskan canneries "in one day 20,000 fish, of an average weight of 10 lbs. each, were thrown away because of the inadequate appurtenances of the establishment and the suddenness of the run" (p. 222).

In the later chapters of his book Mr. Baillie-Grohman gives an entertaining account of his rough and varied experiences as a pioneer in Kootenay, where, among other matters, he was himself hunted and nearly shot by a lawless prospector who had a grievance against him. Mr. Baillie-Grohman took up from the Provincial Government an extensive concession of lands subject to summer floods in the Lower Kootenay valley, and his scheme for the reclamation of these lands affords a striking commentary on the abnormal relations which exist between the main valley system and the present drainage of this region. The physiography of the mountainous country westward from the Rockies to the ocean abounds in anomalous characters which are as yet for the most part unexplained, offering many magnificent problems for the student of the evolution of land-forms; and of these none is more remarkable than the case in question.

The Columbia river, rising in Columbia Lake, flows at first north-westward and afterwards southward, throwing a loop of magnificent proportions northward around the Selkirk Range; while its great tributary, the Kootenay, makes a similar but diametrically opposite loop southward, crossing the United States boundary line into Montana and Idaho, and then recrossing to reach its confluence with the Columbia; and the two rivers thus encircle a huge oval tract of mountains over 300 miles in length. Now, the Kootenay some 80 miles below its source swings into the depression which contains the Columbia Lake, only one mile distant from it, but flows thence southward away from the lake. Mr. Baillie-Grohman's plan was simply to make the circlet of waters complete by turning the Kootenay into the lake.

"The piece of land lying between the two waters was a level stretch of gravel shelving from the river to the lake, the latter being about 11 feet lower than the Kootenay. With such a fall in less than a mile it practically needed very little work, for, once a big ditch was cut, the rushing Kootenay, at that point a rapid stream some 300 feet wide, would do the rest. By turning off such a large quantity of water it was expected that the overflow of the bottom land 300 miles further down would be prevented. It was really restoring things to their original condition, for there is no doubt that a comparatively short time back the Kootenay river forked at the Canal Flat, the northern branch flowing over the flat where I proposed to make the canal, while the southern occupied its present bed" (p. 261).

But rival interests were involved. The Canadian Pacific Railway had been planned to run along part of the Columbia valley just above high-water mark, and its authorities took alarm at the possibility of a vast increase in volume of the river, and prevailed upon the Federal Government to stop the scheme. The upshot, as told by Mr. Baillie-Grohman, is by no means to the credit of the Dominion and Provincial Governments. And thus the waters of the Columbia and Kootenay, after so nearly embracing in their youth, have still to make their separated journey of, together, nearly 800 miles before they unite in full maturity.

In his rendering of the colloquial slang of the West, Mr. Baillie-Grohman is not particularly happy. The examples he gives are generally overdone, the really vigorous expressions being weakened by being crowded in unwarranted sequence. When he defines a "rustler" as being synonymous with a pilferer, he is decidedly mistaken (pp. 276–8). The "rustler" is a man of energy and resource, one fit for any emergency—a man who, in Western parlance, "could hang himself up on a nail to sleep," and there is no opprobrium implied in the term. The point is of some importance, as a stranger to the country, following Mr. Baillie-Grohman's usage of the word, might unwittingly give serious offence.

The illustrations of the book, reproduced from excellent photographs, deserve praise. They have been selected to show the character and conditions of the country as well as its animal life, and serve this purpose well, though they are not always strictly applicable to the text.

G. W. L.

EUGENIO BELTRAMI.

BY the death, on February 18, of Prof. Eugenio Beltrami, after a long illness followed by an unsuccessful surgical operation, Italy has lost a mathematician who did much to bring his country to the forefront in the mathematical world almost simultaneously with the ascendancy of Italy in the world of politics.

Eugenio Beltrami was born at Cremona on November 16, 1835, of a well-known and highly-cultured Italian family. After completing his school curriculum in his native town, he went to Pavia, and then studied mathematics for three years under Brioschi. For some years Beltrami had to earn his own living, and an appointment in the Administration of the Italian Railways, which he held first at Verona, and then at Milan, if it afforded him no scope for his mathematical abilities, at any rate furnished him with the means of subsistence. At Milan, in 1860, Beltrami became acquainted with Cremona, whose influence, combined with a study of the works of Gauss, Lagrange and Riemann, opened the way for his development of higher geometry, in which branch of mathematics Beltrami published his first papers, in 1862, in the *Annali di Matematica*.

In the same year he was appointed professor extraordinarius in algebra and analytical geometry at Bologna, and in the following year he became professor ordinarius of geodesy at Pisa, where he enjoyed the friendship of Riemann and Betti. In 1866, Beltrami returned to Bologna, where he occupied the chair in rational mechanics. Two years later appeared what has been aptly regarded as Beltrami's masterpiece, the "Saggio d'interpretazione della geometria non euclidea," published in the *Giornale matematico di Napoli*. We learn that Beltrami's attention was first attracted to this subject by an observation of Lagrange on maps, in which geodesics are represented on a plane by straight lines, and was thus led to consider the properties of surfaces on which the geodesics are represented by linear equations in curvilinear co-ordinates. Beltrami found that such surfaces were the same as surfaces of constant curvature.

He was thus led to examine the properties of the surface of constant negative curvature, to which he gave the name of *pseudosphere*, and the geometry of such a surface was found to be identical with the geometry of Gauss and Lobatschewsky. As his old pupil and successor at Pavia, Prof. Carlo Somigliana, remarks, "It can thus be said that although the germs of his results can be traced back to some of his predecessors, and, in particular, can be found in the profound considerations of Riemann, and other advances have come subsequently, yet his work represents and synthesises the most decisive step that has been made in modern times by the geometric conception of real space."

Nor was the "Saggio d'interpretazione" by any means Beltrami's only contribution to mathematical literature at the period under consideration. We find him extending the properties of surfaces of constant curvature to n dimensional space; and his papers on differential parameters, on the flexure of ruled surfaces, and on the general theory of surfaces, published a few years previously to the "Saggio," are well known to mathematicians.

In 1873, Beltrami migrated to Rome as professor of rational dynamics and higher analysis, and was elected a Fellow of the Italian equivalent of our Royal Society, the Reale Accademia dei Lincei. His sojourn in Rome was of brief duration; for, much to the regret of his friends there, he went to Pavia in 1876, where he lectured on mathematical physics and higher mechanics, and it was not until 1891 that an opportunity offered itself for him to return to Rome. It was only two years ago that Beltrami was prevailed on to accept the office of President of the "Lincei," and last year he was unanimously elected to the senatorial rank. As a general rule, however, he avoided all public appointments, and the only other post he held was on the Italian Council of Education. He preferred to devote his entire energies to the studies in which he was interested, and sought no scientific distinctions; still, the laurels which he had well earned were freely showered on him by the academies of Bologna, Lombardy, Turin, Naples, Paris, Göttingen, Brussels, Munich and Berlin; and the London Mathematical Society was also proud to place his name on its list of foreign mathematicians.

We have hitherto spoken chiefly of Beltrami's work as a pure mathematician, but his later investigations tended more especially in the direction of applied mathematics. Hydrodynamics, theory of potential, elasticity, physical optics, electricity and magnetism, conduction of heat and thermodynamics were all made the subject of papers, each of which "shed a bright light on some difficult or controversial point." In the theory of the potential considerable simplifications of method were made, and the papers on potentials of symmetric distributions and on the attractions of ellipsoids are described by Somigliana as "true models of classical elegance." In the theory of elasticity, Lamé's equations were shown to be intimately related to the euclideity of space, and the generalisations for spaces of constant curvature opened up a new field for research, of which Beltrami endeavoured to make use in accounting for the uncertainties in Maxwell's theory, which substitutes action in a continuous medium for action at a distance.

The last period of his researches was devoted to developing Maxwell's theories of electro-magnetic phenomena, a difficult task, for which Beltrami's mathematical knowledge well fitted him. All who have read Maxwell's treatise realise that it contains many obscure points and demonstrations of hardly a rigorous nature, and most of those who have failed to follow his arguments have preferred to regard the results as statements of Maxwell's views, rather than inquire into the validity of the reasoning on which they were based. Beltrami, on the other hand, being well versed in the art of exact expression and the elegances of neatness of analytical form, was not contented with Maxwell's rough-and-ready methods, but devoted long hours of deep thought to co-ordinating and perfecting the ideas which he regarded as incomplete. Among his latest contributions to the *Atti dei Lincei* we notice a paper on thermodynamic potentials published in 1895.

As a professor, Beltrami's lectures are said to have been characterised by the same perfection of style and exactness of form which are so conspicuous in his writings. His genial manner and high culture made him a centre no less in general society than in the scientific world. Shakespeare's epithet, "Cunning in music and in mathematics" well applies to Beltrami, and we learn from Signor Pietro Cassani's obituary address to the Venetian Academy, that having been taught music in his early days by his mother, and afterwards under Ponchielli, he would often delight his friends by his renderings on the piano of the masterpieces of Bach, Mendelssohn and Schumann.

The life that has been brought to such a sad close must have been in many respects an ideal life. Beltrami had every opportunity for devoting himself to the studies which he chose as his life's work; he knew nothing of rivalries and petty jealousies, as he made no enemies; but, on the other hand, we cannot but suppose that his experience of the necessities of making the best of somewhat uncongenial surroundings during his years of railway work had a beneficial influence on his after life, in preventing Beltrami from attempting to live up to a false ideal. His loss adds another to the many gaps in the mathematical world, but his published works form a fitting memorial of their author, and several of them bid fair to be handed down to posterity among the mathematical classics.

We are indebted to Prof. Blaserna, of Rome, for much valuable information on which this account is based.

G. H. BRYAN.

PROF. ST. GEORGE MIVART.

BY the sudden death, at the age of seventy-two, of Prof. St. George Mivart, the world in general and science in particular are distinctly the poorer. For he was essentially a many-sided man; and although an energetic and accurate investigator in several branches of biology, was in no sense a specialist whose efforts were restricted to the elucidation of abstruse facts or the elaboration of theories in which the general public could take little or no interest. On the contrary, ever since 1870, when he first began to contribute to the higher grade of popular reviews, he has kept himself constantly in evidence, and has thus become known to a very wide circle of readers, especially as the apostle of the evolution of organic nature under divine guidance.

St. George Mivart was born at his father's house in Brook Street, Grosvenor Square, on November 20, 1827. He was educated successively at Clapham Grammar School, Harrow, King's College, London, and St. Mary's College, Oscott; his adoption, in 1844, of the principles of the Romish faith being at that time a bar to his matriculating at Oxford, where it was his father's intention that his education should have been completed. In 1851 he was called to the Bar at Lincoln's Inn, but his legal career, if he ever practised at all, was a brief one; and in a short time his attention was concentrated first on medical and later on biological studies. By 1862 Mivart had made such a reputation in medico-biological studies that he was appointed a lecturer at the Medical School of St. Mary's Hospital. Previously to this, in 1885, he became a Fellow of the Zoological Society, of which body he was elected a Vice-President in 1869, and again in 1896; indeed, he continued in the latter office

till 1899, when he was compelled by ill-health to resign. In 1869 his merits were recognised by admission to the Fellowship of the Royal Society. He was likewise a Fellow of the Linnean Society of London, of which body he was Secretary from 1874 to 1880, while he subsequently served for many years on its Council, and at one time as a Vice-President. In 1874 he was appointed Professor of Biology at University College, London. In 1876 he was created a Ph.D. of Rome by the Pope, while in 1884 the degree of M.D. was conferred upon him by the University of Louvain. Subsequently he was nominated Professor of the Philosophy of Biology in the last-named University.

Although various scientific memoirs had previously appeared from his pen, it was in 1870 that Dr. Mivart made his first appearance as an essay-writer in popular reviews; and from that date onwards communications of this nature in the *Quarterly*, *Fortnightly*, and *Contemporary Reviews*, and the *Nineteenth Century*, have made his name a household word. All these were marked not only by conspicuous originality of view, but likewise by a high degree of literary and controversial merit. It is not, however, these communications that it is our present intention to describe. With the appearance, in 1871, of "The Genesis of Species" (two editions of which were issued during the first year of its existence), Dr. Mivart may be said to have first come into prominent public notice; and the attention it attracted may be gathered from the criticisms which it drew from Prof. Huxley and other distinguished evolutionists. As is well known, the author in this volume seeks to put natural selection somewhat in the background as a factor in the evolution of animal life, and to bring into prominence the guiding action of Divine power. An advocate for creation," the author was careful to distinguish between *absolute* and *derivative* creation; stating that it was with the latter alone that the evolutionist had to deal. At the same time he laid stress on the opinion that while man's body was the result of evolution, the origin of his intellect must be sought elsewhere.

The elaboration of his views as to the relationship existing between human intellect and animal nature in general was given first in "Nature and Thought; an Introduction to Natural Philosophy" (1882), and finally in "The Origin of Human Reason" (1889), as well as in various serial articles.

But on these and kindred subjects Dr. Mivart could not have spoken with authority unless he possessed an accurate knowledge of the physical relationships between man and the other Primates, as well as those between the latter and the lower Vertebrates. And, in 1873, the appearance (in Macmillan's "School Class Books") of "Lessons in Elementary Anatomy," and also of a separate essay on "Man and Apes," showed how wide a grasp the author had obtained of Vertebrate anatomy generally, and of that of the Primates in particular. Within such a small compass as the "Lessons," there are few, if any, works where the student can gather such an amount of information.

Dr. Mivart's great interest in the Primates led to his being asked to contribute the article "Apes" to the ninth edition of the "Encyclopædia Britannica"; and the excellence of that essay led, with the author's permission, to the incorporation of its substance in "The Study of Mammals," by Flower and Lydekker. To the same great undertaking Dr. Mivart also contributed the articles "Skeleton" and "Reptiles." The latter article showed that, although the author devoted much of his attention to the anatomy of Mammals, yet that other groups of Vertebrates engaged a considerable portion of his energies. During the seventies, for instance, he published in the *Trans. Zool. Soc.* a "Memoir on the Axial Skeleton of the *Struthionidae*," a second on that of the *Pelecanidae*, and a third dealing with the structure of the fins of the Elasmobranch fishes, and the nature and homologies of Vertebrate limbs generally. The first of these three is an important contribution to our knowledge of the osteology of the Ratite Birds, being even at the present day an epitome of the greater portion of our information on this subject. And his devotion to Avian anatomy continued to occupy much of his attention even in his later years, as is attested by his papers on the bony structure of certain Lories and Parrots which appeared in the *Proc. Zool. Soc.* for 1895 and 1896. In 1892 appeared a small volume on "The Elements of Ornithology," in which Dr. Mivart gives his views on the vexed question of Avian classification. In this he follows, to a great extent, the system proposed by the late Mr. Seebohm.

To revert to his favourite study of Mammals, in the sixties Dr. Mivart was much occupied with the anatomy of the Insectivora, the results of his work being published in the *Journ. of Anatomy and Physiology* for 1867 and 1868, and in the *Proc. Zool. Soc.* for 1871. Subsequently his attention was turned to the Carnivora, and the year 1881 was signalised by the appearance of his work, entitled "The Cat; an Introduction to the Study of Backboned Animals, especially Mammals." To a great extent this volume was modelled on the lines of Huxley's "Crayfish," published a year earlier. And it affords an admirable example of how the detailed study of one particular animal may be made the starting-point of a general survey of its near and remote kindred.

The study of the anatomy of the Cat naturally led Dr. Mivart to devote his attention to that of the other Carnivora; and in 1882 two papers dealing with the classification, distribution, and anatomy of the Æluroid Carnivora were published by him in the *Proc. Zool. Soc.* Three years later (1885) these were followed by a memoir in the same serial, in which the Arctoid Carnivora were dealt with in a similar manner. The amount of detailed work in these three papers, and the elaborate manner in which it is classified and arranged, is worthy of all admiration, and renders them a mine of information for the anatomist. Unfortunately the author paid no attention to the palæontological aspect of the subject, and was accordingly unaware how essentially false and misleading is the division of the Carnivora into the Æluroid, Cynoid, and Arctoid groups.

After devoting so much time to the study of the first and third of these groups, Dr. Mivart turned his attention to the third; and in 1890 three papers on the *Canidae* made their appearance in the *Proc. Zool. Soc.* In the same year the quarto "Monograph of the *Canidae*" saw the light.

To this long list of literature, which only embraces a portion of Dr. Mivart's work, it must suffice to add that a small but useful little volume from his pen, entitled "Types of Animal Life," made its appearance in 1893.

The result of all the work bestowed on the Carnivora and Insectivora was largely to increase our knowledge of the anatomy of these groups; the most remarkable feature connected with these investigations being the care bestowed on the arrangement and tabulation of the data acquired. In this respect Dr. Mivart's work is a model for future investigators.

As a lecturer, Dr. Mivart was frequently before the public, both at the Zoological Gardens and at the London Institution; and he had that charm of manner and intonation which could surround with a halo of interest even the driest and apparently most unpromising subjects of zoological research. This charm of manner—largely due to a suave and old-fashioned courtliness which survives only in a few instances at the present day—was equally conspicuous in the ordinary intercourse of life. And to all who enjoyed the privilege of his acquaintance and friendship, his cordial greeting—whether when acting in the *rôle* of host, or at a casual meeting—will long survive as a pleasant memory of a remarkable and distinguished personality.

R. L.

NOTES.

THE Huxley Memorial Statue will be unveiled at the Natural History Museum on April 28, at 1.15 p.m. Sir J. D. Hooker, G.C.S.I., F.R.S., who was Huxley's life-long and most intimate friend, will present the statue on behalf of the subscribers, and H.R.H. the Prince of Wales will receive it on behalf of the Trustees of the British Museum. Invitations are being sent out to the subscribers, and seating accommodation is being prepared for about three hundred persons expected to attend; there will be additional accommodation for those who are content to stand in the galleries overlooking the ceremony. The statue, which is in white marble, is the work of Mr. O. Ford, R.A., and will be mounted on a marble pedestal, and placed under the arch of the first right-hand recess on entering the Hall of the Museum. This position has been decided upon after careful consideration, and trial with others, as fulfilling the conditions of lighting, &c., which will enable the statue to be seen to the best advantage.

INVITATIONS have been sent out for the first (or gentlemen's) soirée of the Royal Society, to be held on Wednesday, May 9.

THE eighth "James Forrest" lecture of the Institution of Civil Engineers will be by Sir William Preece, K.C.B., F.R.S., on Monday, April 23, the subject being "The Relations between Electricity and Engineering." The lecture will be repeated on the afternoon of the following day.

PROF. W. HITTORF, professor of physics at Münster, has been elected a correspondant of the Paris Academy of Sciences, in succession to the late Prof. Wiedemann. The election of Sir George Stokes as Foreign Associate of the Academy left a vacancy for another correspondant in the section of physics, and Prof. Van der Waals has been elected to fill it.

THE next meeting of the Physical Society will be held on April 27, at 8 p.m., at the Solar Physics Observatory, South Kensington, when Sir Norman Lockyer, K.C.B., will give a short account of the physical problems now being investigated at the Observatory, and their astronomical applications. If the night is fine, the 36-inch reflector, and 10-inch and 9-inch refractors, will be used for the observation or photography of celestial objects and their spectra. The large Apps-Spottiswoode coil and Rowland grating will also be shown in operation.

THE following are among the lecture arrangements at the Royal Institution, after Easter:—Dr. Hugh Robert Mill, three lectures on studies in British geography; Dr. Alexander Hill, two lectures on brain tissue considered as the apparatus of thought; Prof. Dewar, four lectures on a century of chemistry in the Royal Institution; Prof. Stanley Lane-Poole, two lectures on Egypt in the Middle Ages; Dr. Alfred Hillier, two lectures on South Africa, past and future. The Friday evening meetings will be resumed on April 27, when a discourse will be given by the Right Hon. Lord Kelvin on nineteenth century clouds over the dynamical theory of heat and light; succeeding discourses will probably be given by Prof. T. E. Thorpe, Prof. J. A. Ewing, Mr. Francis Fox, Sir Henry Roscoe, and others.

ON the recommendation of the Fire Brigade Committee, the London County Council have agreed to accept the offer of the Wireless Telegraph and Signal Company (Marconi system) to instal and maintain for a period of two years, in consideration of an annual payment of 50*l.*, the necessary electrical instruments to enable communication to be maintained between the fire-station at Streatham Green and a temporary sub-station in Mitcham Lane, Streatham.

PROF. A. R. FORSYTH, F.R.S., has been elected a member of the Athenæum Club under the provisions of the rule which empowers the annual election of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE first of a series of four zoological lectures will be delivered in the Zoological Society's meeting-room on Thursday next, April 19, at 4 30 p.m. Mr. A. Smith Woodward will speak on the subject of the animals of Australia, and will discuss the difficult question of the origin of Australian fauna.

DR. W. S. CHURCH has been re-elected president of the Royal College of Physicians of London, by a practically unanimous vote.

THE *British Medical Journal* states that, by a recent order of the French Army Medical Service, medical officers are directed to use injections of antitetanus serum in large and repeated doses in all cases of pronounced tetanus. This order is based on the fact that experience has shown that such injections have a favourable effect in many cases.

THE exhibition of pictures by the National Record Association, at the rooms of the Royal Photographic Society, will close on Saturday, April 21. On Wednesday, April 25, Mr. F. H. Evans will inaugurate an exhibition of his photographs (mainly architectural) at 8 p.m. with an address. Tickets may be had on application to the secretary of the Society.

TO afford an opportunity for observing the total solar eclipse of May 28, from the deck of a ship, the Orient Line have arranged to navigate the Royal Mail steamer *Ormuz* so as to bring the ship upon the central line of totality, off the coast of Portugal, at the time of the eclipse. The journey will be from London or Plymouth to Gibraltar or Marseilles, and the *Ormuz* will leave London on May 25. Passengers will be able to return from Gibraltar or Marseilles by sea, or can travel back from Marseilles overland. The complete journey can be made in fifteen days.

Science states that Princeton University will send a party to Wadesboro', North Carolina, to observe the eclipse of May 28, that place having been selected because it is the most easily accessible of the stations where the weather probabilities are equally good. The party will probably consist of Profs. Young, Brackett, Magie and Reed, Mr. McClenahan, Mr. Russell and Mr. Fisher, with perhaps one or two others. The work undertaken will be mainly spectroscopic, including particularly a determination, both photographic and visual, of the position of the corona line. A set of photographs of the corona will also be taken, and careful visual observations will be made to determine the relations between the corona and the solar prominences.

SIR ANDREW DOUGLAS MACLAGAN, whose death is announced, was born at Ayr on April 17, 1812. He was Surgeon-General to the Queen's Bodyguard, Scotland; vice-president of the Royal Society, Edinburgh; honorary member of the Royal Medical Society, Edinburgh; professor of medical jurisprudence and public health in Edinburgh University from 1862 to 1892, when he retired; president of the Royal College of Physicians, Edinburgh, 1884; and president of the Royal College of Surgeons, Edinburgh, 1859-60.

WE have just received news of the death of Mr. George Highfield Morton, well known for his researches on the geology of Lancashire and North Wales. The first edition of his "Geology of the country around Liverpool" was published in 1863; a second edition, which included an account of the north of Flintshire, was issued in 1891, and an appendix to this work, with a geological map of the district, was published in 1897. Mr. Morton contributed many papers to the Liverpool Geological Society, of which he had been president; his more important researches being on the Glacial and Triassic deposits near Liverpool, and on the Lower Carboniferous rocks and fossils of North Wales. He was elected a Fellow of the Geological Society in 1858, and was awarded the Lyell medal in 1892. He was a constant attendant at Section C of the British Association, and was highly esteemed by all who knew him, as a quiet, unostenta-

tious, but most zealous and enthusiastic worker. He died on March 30, aged seventy-three.

IT was announced at the opening meeting of the Institution of Naval Architects last week, that the council have accepted an invitation from the president of the Association Technique Maritime, M. L. de Bussy, to take part in the International Congress of Naval Architects and Marine Engineers, which is to be held in connection with the Paris International Exhibition. To promote the success of this Congress, it has been determined not to hold a separate summer meeting of the Institution this year. An invitation has been received and accepted from the Lord Provost, Magistrates, and council of Glasgow, to visit that city in the year 1901. The council have awarded a gold medal to Mr. J. Bruhn for his paper on "The Stresses at the Discontinuities in a Ship's Structure," and a premium to Prof. W. E. Dalby for his paper, "The Balancing of Engines with special Reference to Marine Work." In the course of his presidential address, the Earl of Hopetoun referred to the necessity for restricting the employment of wood in all fighting ships. Many foreign nations are entirely abandoning the use of wooden decks and wood fittings in their military marines. Among the subjects of papers brought before the Institution were:—The action of bilge keels, by Prof. G. H. Bryan, F.R.S.; changes and developments in the construction of ships for the mercantile marine during the last forty years, by Mr. B. Martell; distribution of pressure due to flow round submerged surfaces, by Prof. Hele-Shaw, F.R.S.; strength of elliptic sections under fluid pressure, by Captain W. Hovgaard; mysterious fractures of steel shafts, by Signor R. Schanzer; experimental method of ascertaining the rolling of ships on waves, by Captain G. Russo; influence of depth of water on the resistance of ships, by Major G. Rota; and the balancing of steam engines, by Herr Otto Schlick.

AN interesting illustrated article upon the construction of the electric railway to the summit of the Jungfrau, and the electric locomotives in use upon the completed sections, appears in the *Engineering Magazine* (April). The total expense of boring the tunnel, which will be ten kilometres long when completed, is expected to be 200,000*l*. The method of boring is to pierce a series of holes about a metre deep with two electric drills, and then to explode cartridges in them. As the blasting operations can only take place about four times a day, the daily progress is comparatively small—only four metres. The débris passes into tipping waggons worked by an endless rope, and is emptied out at the nearest cross tunnel. At the entrance to the gallery there is a temporary building containing two three-phase 200-kilowatt transformers, reducing pressure from 7000 to 500 volts. The three-phase, low-tension currents thus obtained are used for driving the electric drills, working a ventilator to clear out the smoke after an explosion, and providing power to melt snow for the drills. When the tunnel reaches a height of above 3000 metres, it is expected that difficulties will be encountered on account of mountain sickness. At present the majority of the workmen employed are Italians, but above 3000 metres it is almost certain that they will have to be replaced by Swiss mountaineers. The last station of the railway will be about 66 metres below the summit, which is 4166 metres above sea-level, and the journey from it to the summit will be accomplished by means of a lift. A permanent meteorological observatory wil be erected on the summit, the Railway Commission providing 100,000 francs towards its establishment, and 6000 francs annually towards its maintenance.

A PRELIMINARY report on the determination of the mass of a cubic decimetre of water is published to the *Procès verbaux* of the French International Committee of Weights and Measures, by Dr. C. E. Guillaume. The method adopted was essentially the same as those used in previous determinations, consisting in the observation of the weight of water displaced by a body the dimensions of which were carefully measured. Dr. Guillaume employed cylindrical forms, and from the mean of observations made with five cylinders of varying dimensions, the specific mass of water at 4° was found to be 0·999936.

SOME observations on the influence of heating on the passage of electricity through rarefied gases are contributed to *Wiedemann's Annalen* by Herr J. Stark. When the space between the electrodes is just sufficient to prevent a discharge from taking place, the introduction of an incandescent body causes the discharge owing to the resistance of the gas decreasing on its being heated. Similarly the fall of resistance caused by the use of an incandescent kathode enables a comparatively small electromotive force to produce a luminous discharge. Herr Stark has passed on to consider the case where the electromotive force is about 100 volts. higher than that which would just suffice for the discharge. In this case it is found that by the introduction of a white-hot body all luminosity may be made to cease, the electric discharge being dark. This effect the author attributes to the heated gas having lost its power of phospherence during the passage of electricity, a transformation which, moreover, is to be accounted for by the gas becoming dissociated by the action of heat, coupled with the property that no phosphorescence occurs in a dissociated gas.

A REINVESTIGATION of the question as to whether the viscosity of dielectric liquids is affected by a uniform electrostatic field is given by Dr. G. Pacher and Dr. L. Finazzi in the *Atti del R. Istituto Veneto*, lix. 2. Contrary to the results of Duff and Quincke, no variations in the viscosity were observed to be caused by the electric field. The method of experimenting was to measure the time of efflux through a pair of liquid condensers, and the liquids operated on were distilled water, ethyl-alcohol, ether, benzol, oil of turpentine and sulphide of carbon. The times of efflux vary slightly in individual experiments, owing to errors of observation; but there is no difference between the means of the results for charged and uncharged condensers beyond what is naturally attributable to accidental causes.

THE chief theorem of Lie's theory of continuous groups receives discussion at the hands of Mr. Stephen Elmer Slocum in the pages of the *Proceedings* of the American Academy of Arts and Sciences. The theorem in question is that a particular system of r independent infinitesimal transformations generates a continuous group with r parameters, that is, a group with r parameters in which each transformation can be generated by an infinitesimal transformation of the group. Prof. Study, however, has shown that, notwithstanding the infinitesimal transformations of the special linear homogeneous group satisfy Lie's criterion, nevertheless, not every transformation can be generated by an infinitesimal transformation of this group. Consequently Lie's theorem is subject to certain limitations. So far as Mr. Slocum is aware, the precise nature of the error has not been pointed out, and to show wherein it consists is the object of his paper. The author carries out for a particular group the successive steps in Lie's demonstration of the first fundamental theorem of his theory, upon which the chief theorem, namely the second fundamental theorem, rests. At a certain point in this demonstration an assumption is made in which Lie's error consists.

IN the *Meteorologische Zeitschrift* for January, Dr. H. Hergesell continues his valuable discussion of the results of recent international balloon ascents. In this paper he discusses the effect of the density of the air upon the coefficient of inertia of a ventilated thermometer. With respect to the ascents of unmanned balloons, he finds that the registering thermometers, although they may be properly protected against solar radiation, only give accurate results during the ascent,

and that even these results require a two-fold correction, owing to the radiation of the parts of the balloon in the vicinity of the thermometers and to the sluggishness of the instruments. The observations during the descent must be used with great caution, as in many cases the thermometers are coated with a deposit of aqueous vapour, which obstructs their proper working. With respect to the temperature conditions of the higher air-strata, the observations up to an altitude of 10,000 metres show in all cases a decrease with height of 40° C. or more. In no case is a decrease in the magnitude of the variation shown with increasing altitude. The various ascents show a great mobility of temperature according to locality; at the same hour differences of 30°–40° C. have been recorded in the higher strata which are only a few hundred kilometres apart.

MR. R. D. WARD records in the *Boston Medical and Surgical Journal* some observations on the condition of the air of an artificially heated room as regards moisture, during winter months. His observations show that the atmosphere of a room is often drier than that of many desert regions.

THE Latian earthquake of July 19, 1899, is described by Dr. A. Cancani in the last *Bollettino* of the Italian Seismological Society. At Frascati, Marino and Grottaferrata, much damage was caused by the shock, and several interesting examples are described. The record obtained by the great seismometrograph at Rocca di Papa shows two very distinct phases before the principal movement began, the first of which Dr. Cancani considers as responsible for the prior effects on animals, and the second for the preliminary sound heard by man. The shock was felt over an area of about 80,000 sq. km., and was also recorded by a seismometrograph at Catania, the waves having travelled there with a mean velocity of 5·5 km. per second. Earlier on the same day occurred the explosion of Etna, and the rainfall for the seven previous weeks was nearly three times the average for the time of year.

IT is but too seldom that our military officers stationed in remote districts devote some of their spare time to the investigation of the natural history of the surrounding country, and we have therefore the more pleasure in welcoming a paper in the *Journ. Asiatic Soc. Bengal*, for 1899, by Capt. A. H. MacMahon (son of General MacMahon), on the fauna of the Gilgit district. The author has added the Ermine to the list of Gilgit mammals, and has also shown that the Bharal (*Ovis nahura*) extends westward into the Hunza valley.—To the same journal Mr. de Nicēville and Major Manders contribute a paper on the butterflies of Ceylon, containing a complete list of the fauna.

ABNORMAL colour-variations in British Lepidoptera forms the subject of a paper (illustrated by a coloured plate), by Mr. Frohawk, in the April number of the *Entomologist*. Very curious is a brown variety of the Tiger-moth, in which the blue spots on the hind wings are, however, retained. In this communication the author very properly refrains from giving names to such individual "sports." Not so a writer in the April number of the *Journal of Conchology*, who proposes to designate a white snail from Gibraltar, *Helix marmorata*. var. *alba*. In view of the present employment of trinomialism to indicate geographical races, such a usage is quite unjustifiable.

THE third of the Liverpool Marine Biological Committee's Memoirs on typical British Marine Animals and Plants is to hand, under the title of "Echinus," by Mr. H. C. Chadwick. It is an admirably written and beautifully illustrated "booklet"; but if the editor wishes to attract popular attention to this series, would it not be better if he used the names "Cockle" and "Sea-urchin" in place of "Cardium" and "Echinus"?

THE issue of the *Proceedings* of the Philadelphia Academy of January 2 contains an interesting paper, by Mr. L. Stone, on the Birds and Mammals collected by a recent expedition to Point Barrow, Alaska. It is stated that, so far as the antlers are concerned, the Barren-ground Caribou of Alaska is indistinguishable from the Greenland Caribou (or Reindeer), although the two are generally regarded as distinct races.

PROF. SYDNEY YOUNG, F.R.S., contributes to the April number of *Good Words* an appreciation of the life and work of Dr. W. H. Perkins, F.R.S. The article is the third of a series, entitled "Present Day Leaders of Science."

THE first number of a new quarterly—*The Humane Review*—has been received. Mr. G. Bernard Shaw writes pleasantly upon nothing in particular, under the title of "The Conflict between Science and Common Sense." He seems to be grieved because science is progressive, and that cherished beliefs of yesterday are disturbed by discoveries of to-day. Mr. W. H. Hudson laments the disappearance of the Furze Wren, or Dartford Warbler, from most parts of England. Other articles deal with various ethical and humanitarian subjects.

THE discovery of Dr. Cohen that metallic tin can exist in two modifications, white and grey, only one of which is stable at a given temperature, led him to study the velocity charge of white tin into grey tin (see NATURE, p. 330). It was found that the velocity for the temperature interval, 10° to 20° C., was extremely small, so small that years would be necessary to prove the change. Dr. Cohen now quotes (*Zeitschrift für Physikalische Chemie*, **23**, 59) some remarks of Dr. Gowland upon the condition of a pewter vase of date about 350 A.D., from which it would appear that the change into grey tin was practically complete after 1500 years, a conclusion confirmed by a dilatometric study of some of the material.

THE field of research opened up by M. Becquerel by his discovery of the radiation from uranium salts, is now being rapidly enlarged by many workers. Besides the radio-active elements, polonium and radium, discovered by M. and Mme. Curie, particulars are given by M. A. Debierne, in the *Comptes rendus*, of another element having similar properties, but belonging to the iron group of metals. It is extracted, like polonium and radium, from the residues from the treatment of pitchblend, and is named by the discoverer actinium. As is the case with all these elements, they have not been obtained even in an approximately pure state, the most that can be done being to concentrate the radio-active material in certain precipitates. Thus the chemical reactions of the most active actinium material so far obtained, and also the spectroscopical examination, show that the product is an impure thorium. It can be shown, however, that the effects observed are due neither to polonium nor radium.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂), a Vervet Monkey (*Cercopithecus lalandii*, ♀), two Yellow-billed Ducks (*Anas undulata*) from South Africa, presented by Mr. J. E. Matcham; a White-collared Mangabey (*Cercocebus collaris*, ♀), a Ludio Monkey (*Cercopithecus ludio*, ♀) from West Africa, presented by Mr. D. J. Jones; two Bonnet Monkeys (*Macacus sinicus*, ♂ ♀) from India, presented by Mr. T. W. B. Lindgren; a Fennec Fox (*Canis cerdo*, ♂) from North Africa, presented by Dixon Bey; a Marabou Stork (*Leptoptilus crumeniferus*) from Africa, presented by Mr. Justice H. G. Kelly; a Wedge-tailed Eagle (*Aquila audax*) from Australia, presented by Colonel R. B. Ingram; four Spot-billed Ducks (*Anas poecilorhyncha*) from India, presented by Sir Ed. Chas. Buck, K.C.S.I.; a Common Duiker (*Cephalophus grimmi*, ♀) from South Africa; a Small-clawed Otter (*Lutra leptonyx*), a Bengal Monitor (*Varanus bengalensis*) from India; a Common Hare (*Lepus europoeus*), British; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; two Squirrel-like Phalangers (*Petaurus sciureus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ROTATION PERIOD OF VENUS.—A telegram just received from Herr Backlund, through the Centralstelle at Kiel, reads as follows:—"From four spectrograms Belopolsky has been able to confirm the *short* rotation period of Venus."

ELLIPTIC ELEMENTS OF THE VARIABLE Y CYGNI.—Prof. N. C. Dunér, of Upsala, has computed the elliptic elements of the Algol Variable Y Cygni, and gives his results with a derived ephemeris in the *Astronomische Nachrichten*, Bd. 152, No. 3633.

Elements of Y Cygni.

Epoch	$t_0 = 1885{\cdot}0 + 342{\cdot}8930$d.
Anomalistic motion of apse line ..	$\omega = 0°{\cdot}035928$
Eccentricity	$e = 0°{\cdot}14535$
Anomalistic revolution	$U = 2{\cdot}996933$d.
Semi-major axis	$A = 8{\cdot}0$

PHOTOMETRIC OBSERVATIONS OF MERCURY DURING SOLAR ECLIPSES.—Dr. G. Müller, of Potsdam, has for some years made systematic measurements of the brightness of the planet Mercury for phase-angles varying from 50° to 120°. No observations could be made nearer than 50° from the sun. From his results, he finds that the relation giving the light-curve of Mercury is almost identical with that obtained by other workers in the case of the moon. This similarity could be very severely tested if the brightness of the planet could be determined directly at the phase-angles from 0° to 50°. In the *Astrophysical Journal* xi. pp. 144–147, he suggests that an excellent opportunity to carry out this work will be presented during the coming total eclipse in May 1900. The phase-angle for Mercury at the time of the eclipse will be about 7°, and its angular distance from the sun about 2°.

Venus will be the most suitable object for comparison, being about 40° east of the sun at the time of the eclipse, with a phase-angle of 113°. It will be advisable to use small objectives of very short focus, so that the images of the planets may appear as practically points of light; it is also desirable to employ only those photometers with which (as is the case of Zöllner's) the effect of the different brightness of sky background is eliminated.

VARIATION OF LATITUDE.—Prof. Th. Albrecht, of Potsdam, gives a *résumé* in the *Astronomische Nachrichten*, Bd. 152, No. 3633, of his continued discussion of the results obtained at various stations for the motion of the earth's pole. The observations have been made at the following stations:—Tokyo, Kasan, Moscow, Pulkowa, Prague, Potsdam, Lyons, New York, Philadelphia and Washington, during various periods extending from 1892·3 to 1899·9. The co-ordinates of the pole as deduced from these new results are plotted in continuation of Prof. Albrecht's former curve. During the period 1895·0 to 1895·6, the motion appears from the curve to have been in the opposite direction to that followed since, although several complete revolutions have taken place.

PLANETARY WORK AT THE MANORA OBSERVATORY.—Herr Leo Brenner communicates to the *Naturwissenschaftliche Wochenschrift*, Bd. xv. No. 13, pp. 145–150, his report of the work done at the Manora Observatory during the past year. Besides the drawings of the planetary markings, which is the chief undertaking of the institution, the scope of routine work included observations of the sun, zodiacal light, double stars and meteors. The report is illustrated by twenty-eight reproductions of drawings of the planets Mars, Jupiter and Saturn, showing the various markings mentioned in the text. The spots on the ball of Saturn appear to have been continually seen.

THE DEVELOPMENT OF ASTRONOMY IN AMERICA.

SIXTY years ago the United States had scarcely a single observatory properly equipped for the pursuit of astronomical studies. To-day that country is possessed of the finest observatories in the world, manned by observers of the greatest skill, who devote themselves untiringly to the advancement of the oldest of the sciences.

The success of the American astronomers during this short period has been remarkable. To them we owe important discoveries and precious records in nearly every branch of theoretical and practical astronomy, and especially of late years in the department of astronomical physics. It is impossible here to recount the whole fruits of their labours, but it is worth while to recall a few of the results which we owe to their industry.

The first striking discovery in America was that of Hyperion, the seventh satellite of Saturn, by G. P. Bond, in 1848. In the same line of work, Hall was rewarded in 1877 by the discovery of the tiny satellites of Mars, and more recently Barnard astonished the world by his detection of the fifth satellite of Jupiter, while Pickering claims to have established the existence of a ninth satellite of Saturn. In planetary studies generally, the Americans have been well to the front, and we have seen the unusual spectacle of a powerful refractor primarily devoted with marked success, by Mr. Lowell, to the delineation of the surfaces of our nearest planetary neighbours. Numerous measurements of the dimensions of the various members of the solar system have also been made, and the theory of their motions has been greatly advanced, notably by the well-known investigations of Newcomb.

Cometary astronomy has likewise benefited by their zeal, many new discoveries having been made, and the orbits of a large number calculated; in this branch the Americans are now more active than ever, no less than six of the seven new comets discovered in 1898 being to their credit. Important investigations relating to meteorites and the orbits of meteor swarms have also been carried out, and the name of Prof. H. A. Newton will always be associated with this department of astronomical research.

Sidereal astronomy has been enriched by numerous star catalogues, and double-star observation has been brought to a high standard of perfection by the assiduous efforts of Burnham, Hall and See; while Pickering's "Harvard Photometry" has given us an invaluable record of the magnitudes of thousands of the brighter stars. The study of variable stars has also been very productive, our most important catalogue of these objects being due to Chandler, while a unique atlas of variable stars is in course of publication by Prof. Hagen; here, as in many other directions, Prof. Pickering's ingenuity has been displayed, and he has shown among other things how variables of short period can be readily detected, and the changes studied, by photographic means.

Our catalogues of nebulæ discovered since the time of the Herschels include a large number of entries to the credit of American observers, Lewis Swift having specially distinguished himself in this field of work.

Notable work has also been done in the domain of solar physics. Young's observations of the chromospheric spectrum have only been surpassed by the most recent eclipse photographs, and Prof. Hale was the first to initiate a regular photographic record of the forms of the chromosphere and prominences. Quite recently, the great telescope of the Yerkes Observatory has been used for a very detailed examination of the spectrum of the chromosphere, and even the most minute structure of the carbon flutings in the green has been successfully observed. To Prof. Rowland we owe a great catalogue of close upon twenty thousand of the Fraunhofer lines, the positions of which are stated with a degree of accuracy never before attempted; and physicists and astronomers throughout the world are indebted to this observer for the magnificent diffraction gratings which his skill has placed at their disposal. By the invention of the bolometer, Langley has opened up a new region of the spectrum, and has made numerous important observations by its aid. At the present time a committee of American astronomers is organising the work to be undertaken during the total eclipse of the sun next May, and from a preliminary report which has been issued we gather that they are fully alive to the opportunities which such an event affords.

Astronomy owes an immense debt to photography, and it should not be forgotten that the first photographic impression of a star was obtained on the other side of the Atlantic, by Prof. Bond, in 1850. Among those who early recognised the possibilities of astronomical photography was Rutherfurd, of New York, who obtained numerous pictures of the sun, moon and stars in the early seventies, the full value of which has only lately begun to appear. It was there also that Dr. Draper, in 1872, secured the first photograph of a stellar spectrum which revealed anything relating to the composition of a star, and that Barnard, in 1892, made the first discovery of a comet by the aid of the camera.

The story, however, by no means ends with this pioneer work; celestial photography has been pursued with the

greatest success in every direction, notable among the results being Barnard's photographic delineation of comets, nebulæ, and the Milky Way, and the magnificent spectroscopic work of the Henry Draper Memorial carried on by Prof. Pickering at Harvard College.

Within the last few years the energetic director of the Harvard College Observatory has been enabled to extend his operations by the erection of a well-equipped observatory in the clear air of Arequipa, Peru, spectroscopic and other data on a uniform plan for the whole celestial vault being thus secured. Prof. Pickering has, in fact, developed the photographic side of his work into a wonderful detective force, so perfectly organised that no new star of reasonable brightness can escape detection, and no important change in a known star go unrecorded. The munificent gifts to the Harvard Observatory have thus, in Prof. Pickering's hands, been put to the best possible uses.

The work of the Lick Observatory is also largely photographic. Here, the great refractor has been employed with the greatest success by Prof. Campbell in photographing the spectra of nebulæ and bright line stars. More recently special attention has been given to the photographic determination of stellar velocities in the line of sight, with the result that a dozen or so of spectroscopic binaries have already been detected, Polaris and Capella being among the most interesting systems thus recognised. Quite recently, marvellous results have been obtained by Prof. Keeler in photographing the forms of nebulæ with the Crossley reflector. The Director's report for the year ending September 1, 1899, indicates a remarkable state of activity among the comparatively small staff of this observatory. The success of these observers is doubtless in some measure due to the wisdom displayed in the limitations which they have set to their work. A well-defined programme, and concentration upon it, appears to be the policy adopted, and the truly scientific spirit which controls their investigations is exhibited by the following remarks from Prof. Keeler's last report: "Comets which are bright enough to be easily seen at the leading observatories receive only occasional attention, while comets which, by reason of their faintness or unfavourable position, are difficult of observation, are followed as closely as possible. . . . The Lick Observatory makes the most of its natural advantages; and extended theoretical researches, which can be made as well in a city as at a fine observing station, do not form part of our general plan." In this way the output of useful observations is greatly increased, and the co-ordination of different facts can be carried on by workers generally. The same spirit prevails at Harvard Observatory, where "precedence has been given to physical work, since less attention is paid to such work elsewhere," and the photographic records there accumulated have been placed at the service of any one properly qualified to discuss them.

The Yerkes telescope, in the hands of Burnham, Barnard and Hale, has already been very productive. One of the most important pieces of work undertaken here is the photographic registration of the spectra of the Piscian (III.*b*) stars; and the wealth of detail recorded in such difficult objects is truly remarkable.

But it is by no means only in observatories furnished with giant telescopes that astronomical science has been advanced. Admirable work has also been done in unpretentious establishments, and, indeed, with no observatories at all. Gould's investigation of the Milky Way and the distribution of stars is a case in point, and to take another example, a vast amount of energy has been expended in perfecting the *American Ephemeris* and *Nautical Almanac*. Chandler's masterly investigations of the variations of terrestrial latitude also demand separate mention.

Terrestrial researches bearing on astronomical phenomena have not been neglected. Newcomb and Michelson's determinations of the velocity of light are classical examples, and among more recent work reference may be made to Rowland's determinations of the origins of a vast number of Fraunhofer lines, and to Humphrey's and Möhler's investigations of the displacement of spectrum lines due to pressure.

It will be seen, even from this incomplete statement, that the output of astronomical work in America has been very great, and there is every indication that it will go on increasing. The rapid development is doubtless due to various causes, not least among them being the unstinted support given by private benefactors. The American astronomers undoubtedly also owe a great debt to their opticians and engineers, the Lick and Yerkes refractors, with their apertures of 36 and 40 inches respectively, being the crowning triumphs of the instrument makers. Messrs. Alvan Clark's telescopic object glasses have long been justly held in high estimation all over the world, and the skill of Messrs. Warner and Swasey has been fully equal to the task of successfully mounting their mammoth productions.

Some of the success of the Americans may perhaps be attributed to their wise selection of sites for their instruments, when they have been free to exercise their judgment. The Lick Observatory, at an elevation of 4000 feet, is favoured with exceptionally good atmospheric conditions, and the sites of the Yerkes and various other observatories were only decided upon after very careful trials.

Instrumental equipment and good climate, however, are not the only requisites for a successful observatory. Much depends upon the men at the little ends of the telescope tubes, and, we may add, upon the men at their desks or in their laboratories, who bring their minds to bear upon the explanation or utilisation of the phenomena observed, besides suggesting further observations. The training of astronomers is therefore of as much importance as the provision of instruments. Fortunately, America can boast of unparalleled facilities for this necessary training. Students' observatories abound, and in many cases instruction of the most advanced character is obtainable. Of elementary instruction it is scarcely necessary to speak; but American students are to be congratulated if the teaching generally is on such enlightened lines as those indicated in Miss Byrd's "Laboratory Manual of Astronomy," and Prof. Todd's "New Astronomy." A most valuable paper, by Prof. E. S. Holden, on the teaching of astronomy in primary and secondary schools and in the university has recently been published.[1] During the early years of a child's school-life, the lessons must necessarily be simple; and Prof. Holden gives an extremely suggestive sketch of the methods which should be followed, bearing in mind that "the main point is to open the eyes and mind, and the sun and stars are convenient for the purpose." To the teachers of astronomy in secondary schools Prof. Holden also gives many valuable hints. Here astronomy is to be regarded as an "information study," as well as an educative one, and suggestions as to simple apparatus to facilitate the teaching are given.

From our present point of view, however, the most interesting part of Prof. Holden's paper is that referring to the courses of instruction in astronomy offered by some of the American universities and colleges. Particulars are here given of the instruction carried on in fifteen institutions, and they illustrate in the most satisfactory manner the advantages enjoyed by the American student who wishes to acquire an extended knowledge of the subject. The courses are in several cases remarkably comprehensive, and in five of them astrophysics takes an important place in the curriculum. In every case there appears to be an adequate supply of instruments and observatories, and for students desiring to specialise there are abundant opportunities of entering even the best observatories.

The course at the University of Chicago is perhaps the most complete, but the syllabus is too long for quotation; suffice it to say that it includes every department of theoretical and practical astronomy, the astrophysical instruction being carried on at the Yerkes Observatory by the distinguished staff of resident professors and observers. The Director of the Yerkes Observatory some time ago made the following statement as to the relation of that establishment to the work of students:—

"After completing the necessary preliminary work in Chicago, students who desire to devote special attention to observational astronomy or to astrophysics are admitted to the Yerkes Observatory at Lake Geneva, where they are given every possible facility. In addition to pursuing the courses of instruction enumerated in the *Annual Register* of the University of Chicago, students at the observatory may take part in the regular work of research. As soon as they have had sufficient preliminary training, they are encouraged to undertake original investigations of their own." From other notices we gather that this privilege is not restricted to students from Chicago.

At the University of California also an admirable course of astronomy is offered, one item of which may be quoted as illustrating the attention given to practical work:—

"4 A. Practical astronomy. Lectures and observatory work. Navigation and nautical astronomy. Practical work in the

[1] "Report of the Commissioner of Education, 1897–98." Vol. i. p. 869. (Washington, 1899.)

observatory. Six hours observatory, first half. Three hours lecture and six hours observatory, second half."

The University possesses an excellently equipped students' observatory, in addition to the world-famous establishment on Mount Hamilton. Graduates of the University, or indeed of other universities of equal standing, are received at the Lick Observatory to pursue a higher course of instruction in astronomy; every facility consistent with the scientific work of the establishment will be given them, and they will usually be assigned as assistants to some of the astronomers. An illustration of the bond between the greater and lesser establishments is afforded by the recent computation at the students' observatory of the elements of a comet from observations telegraphed by the astronomers at Lick. (Pub. Ast. Soc. *Proc.* vol. xi. No. 70 p. 190.)

From the information which Prof. Holden has collected, we gather that special students of promise have also the privilege of entering into the regular work of the observatories at Harvard College, and the Universities of Yale, Michigan, Virginia, Wisconsin and Pennsylvania.

The special value to the student of this association with the staff of an observatory is admirably stated by Prof. Holden in a report on the Lick Observatory, from which he makes the following quotation: "No institution in the world is better fitted to give such instruction, and there is a special impetus to be gained in an observatory which is regularly pursuing work of discovery and research. The student comes directly into the current, and learns far more by observation of the methods of others than by the study of text-books. He can take part in the regular work of the observatory also." This happy arrangement is not only beneficial to the student. Prof. Holden further remarks: "It is a great advantage to the university as a whole to count among its members a considerable number of active and ambitious young men who are able to work with some independence to advance science, and not merely to acquire what is already known. They set a standard of scholarship to all the undergraduates. Such students can take a useful part in the actual observations of every day as assistants, and after some practice they become valuable aids in our work of computation and observation, and supplement the permanent force of the observatory in an important degree."

No wonder that with advantages like these there is an adequate supply of highly-trained young astronomers capable of fully developing the great resources which the scientific spirit of wealthy Americans has placed at their disposal. It appears to us that it is precisely for want of opportunities for securing the necessary technical training to future observers that the astronomical development of our own country proceeds less rapidly than that of America. While it is possible to obtain a certain amount of tuition in spherical astronomy, and here and there a modicum of practical instruction in the older branches of the subject, facilities for the study of astrophysics are almost completely lacking, and it is a deplorable fact that the universities are especially deficient in this respect.

Under the Science and Art Department a general study of astronomy is encouraged, but the subject is incorporated with a variety of other subjects, under the comprehensive title of Physiography, and no separate certificate for astronomy is granted.

At the universities, astronomical teaching appears to remain in much the same position as the teaching of chemistry and physics before the introduction of practical work in those subjects, the prevailing idea apparently being that if a mathematician can be placed at the head of affairs in an observatory, it matters little who makes the actual observations, or whether observations are made or not. There can be little doubt that means exist for establishing schools of astronomy comparable with those which have arisen for other branches of science, and we sincerely hope that the need for serious attention to practical teaching in astronomy will soon be recognised.

So far as we know, there is only one institution in Great Britain where any attempt is made to give practical instruction in astronomical physics, and even in this case the greater part of the instruction is necessarily of a somewhat elementary character, in consequence of the small amount of time available for the subject.

It is a natural consequence of our inadequate provision for technical education in astronomy—more particularly in the newer branches—that vacancies in our observatories must be filled by observers who have still to make practical acquaintance with the work expected of them. Much loss of time and apparent inactivity is the result.

It may be urged that benefactors of the science of astronomy are less numerous here than in America, but the generous gifts of Dr. F. McClean to Cambridge University and the Cape Observatory, and of Sir Henry Thompson to the Royal Observatory, Greenwich, remind us that they are not wholly wanting. Besides, there are already numerous observatories scattered throughout the country which might be made more productive by putting them in the hands of observers who have received adequate training. Public interest in astronomy is by no means absent, and British observatories would, perhaps, receive a much increased measure of support if it were not for the possible impression that the best work can only be done in America, and that instruments of the largest size are alone useful.

THE FLIGHTLESS RAIL OF NEW ZEALAND.

THE most important ornithological event in New Zealand, in recent years, was the capture of a fourth specimen of the Takahe (*Notornis hochstetteri*), on the west side of Lake Te Anau, in August 1898. Prof. W. B Benham sent us an interesting description of the bird at the time of its capture (vol. lviii. p. 547), and a more detailed account by him is referred to in a paper, by Sir Walter L. Buller, in vol. xxxi. of

FIG. 1.—The rare *Notornis* of New Zealand.

the *Transactions* of the New Zealand Institute (1898), which has just reached this country. The following particulars, with the accompanying illustration, have been derived from this source:—

In size the bird is like a goose, but in colouration it resembles the Pukeko; its breast is a beautiful rich dark blue, becoming duller on the neck, head, abdomen and legs. These last are clothed with feathers for a greater distance than in the native turkey, but they are relatively shorter and much thicker than in the latter bird. One of the most noticeable characteristics of the bird is its beak—a large equilateral triangle of hard pink

horn, with one angle directed forwards. At the upper side of the base of the beak is a bright red band of soft tissue, like an attempt at a "comb," such as is possessed by an ordinary rooster, only transversely placed. The whole is a handsome bird of heavy gait, absolutely unable to use its wings for their natural purpose of flying. Indeed, one of the interests of the bird zoologically is that, like several native birds of New Zealand, it is flightless, though its congeners in other countries are able to fly. The Takahe is closely allied to the Pukeko, and not far removed from the Brown Woodhen; all these belong the family of Rails, which usually frequent more or less marshy ground, and in countries other than New Zealand are able to fly as well as other birds. On the other hand, the Takahe can run very actively, and its powerful beak must be a formidable weapon, which it could use with effect on enemies when at close quarters.

The specimen captured in 1898 is a young female, of practically the same size as the bird examined by Sir W. Buller twenty years earlier. The first specimen of the bird ever captured was taken in 1849, and its skin is now in the British Museum (Natural History). The second was caught in 1851, and is also in the British Museum collection. The third was captured in 1879—nearly thirty years after the second had been taken—and its remains were purchased by the Dresden Museum for one hundred guineas. The specimen caught in 1898 appears to be much the best yet obtained, and as much as 300*l.* was offered for it. The rarity of the *Notornis* and other members of the New Zealand fauna makes it essential, as Sir W. Buller points out in his paper, for naturalists to do everything in their power to possess, if not a few living representatives, at any rate a full life-history of the expiring forms.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A COURSE of six free public lectures on "Prehistoric Chronology" will be delivered by Prof. Montelius at University College, London, on Tuesdays and Fridays at 4 p.m., beginning on Friday, May 4.

MR. J. F. HUDSON has been appointed mathematical lecturer at University College, Bristol, in succession to Mr. J. F. McKean, who has been appointed a mathematical lecturer at the Royal Naval Engineering College, Devonport. Mr. Hudson has for the past three years been assistant lecturer in Jesus College, Oxford, and assistant demonstrator of physics in the Oxford University Laboratory.

MR. W. TUCKER, C.B., a principal assistant secretary to the Board of Education, has retired from the service on reaching the age of sixty-five. The following promotions have been made in the office of the Board of Education:—Mr. J. White (assistant secretary) to be a principal assistant secretary; Mr. F. R. Fowke (assistant director for science), Mr. H. W. Hoare, Mr. W. I. Ritchie, and Mr. H. M. Lindsell to be assistant secretaries.

THE following appointments have been made by the Irish Department of Agriculture and Technical Instruction:—To be superintendent of statistics and intelligence branch, Mr. W. P. Coyne, professor of political economy and jurisprudence, University College, Dublin. To be inspector in agriculture, Mr. J. S. Gordon, Department of Agriculture, Edinburgh University, principal of the Cheshire County Council Agricultural and Horticultural School.

IN commemoration of the fiftieth anniversary of the foundation of the North London Collegiate School for Girls, and in honour of the late Miss Francis Mary Buss, a jubilee number of the school magazine was published on April 4. Mrs. Sophie Bryant, D.Sc., describes the foundation and growth of the school, and shows that it has been a very important factor in the development of secondary education for women. During the past twenty years 59 old students have passed Part I. of the Tripos examinations of the University of Cambridge, and 7 have passed Part II., while 10 have qualified for the ordinary degree. It is noteworthy that 33 of the 59 who passed Part I. took mathematics and natural science as their subjects, and 5 of those who went on to Part II. At Oxford University 9 old students have passed the Honours Moderations (8 taking mathematics), and 8 have passed Final Honours. The College has 116 old students who are graduates of London University, 22 being Bachelors of Science, 4 Bachelors of Medicine, 2 Doctors of Science, and 1 Doctor of Medicine. Since the opening of the degrees of London University to women, 1220 women have graduated, and the North London Collegiate School claims 10 per cent. of this number as old students.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, March.—Prof. Pierpont, in an article on mathematical instruction in France, gives an account of the way in which France is educating students who wish to become mathematicians, and indicates rapidly what positions a talented young man may hope to reach, how he attains them, and what his duties are in the various stages of his progress. He subsequently calls attention to the advantages which Americans can enjoy in studying mathematics in France, particularly in Paris. The article should be useful.—Prof. Ernest W. Brown reviews M. Poincaré's "Cinématique et Mécanismes, Potentiel et Mécanique des Fluides," the *Annuaire* of the Bureau des Longitudes for 1900, and the "Elements of Precise Surveying and Geodesy," by Mansfield Merriman.—Prof. F. Morley gives a sketch of E. Duporcq's "Premiers principes de Géométrie Moderne," a work to give students, who have some acquaintance with analytic geometry, a liking for the purely geometric point of view.—Prof. F. Cajori briefly notices "Opinions et curiosités touchant la Mathématique d'après les ouvrages Français des xvi^e^, xvii^e^, et xviii^e^ siècles," by G. Maupin (a work, apparently, which merits a place in a modern "Budget of Paradoxes"), and "La Mathématique: Philosophie, Enseignement," by C. A. Laisant.—The number closes with the usual items of "Notes" and "Publications."

THE March issue of the *Bulletin de la Société Astronomique de France* contains an interesting article on solar and lunar halos, with particulars and illustrations furnished by several contributors. Reproductions are given of two excellent photographs obtained by M. Basile de Balasny, at Poltava in Russia, one showing distinctly the halo, the other a definite column of light appearing as a prolongation of the sun above the horizon, the time being just after sunset. The same journal contains four photographs of the eclipse of the moon, December 16, 1899, by M. l'Abbé Moreux; M. Flammarion also continues his illustrated series of naked eye drawings of the moon.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 29.—"Certain Laws of Variation." By H. M. Vernon, M.A., M.D., Fellow of Magdalen College, Oxford. Communicated by Prof. Lankester, F.R.S.

In a former paper (*Phil. Trans.*, B, 1895, p. 577) it was shown that the ova of the Echinoid *Strongylocentrotus lividus* were extraordinarily sensitive to their environmental conditions at the time of impregnation. For instance, by keeping the mixed ova and sperm in water at about 26° or 8° C. for an hour, the plutei obtained after eight days' development were some 5 per cent. smaller than those from ova kept at about 20° at the time of impregnation.

By splitting up into groups the 20,600 measurements which have been made from time to time on *Strongylocentrotus* larvæ, according to the amount of effect which had been produced in their size by varying degrees of favourable and unfavourable environment, and by determining the average variability of the larvæ in each group, it was sought to prove the existence of a law of variability. This may be worded as follows:—"An organism varies least when it is best adapted to its surroundings, so that the less it is adapted the more variable does it become."

Entomological Society, March 21.—Mr. C. O. Waterhouse, Vice-President, in the chair.—Mr. R. McLachlan exhibited an extraordinary aberration of *Enallagma cyathigerum*, Charp. The remarkable feature consisted in the predominance of black over blue in the coloration of the abdomen.—Mr.

M. Burr exhibited a macropterous var. of *Xiphidium dorsale*, Latr., captured by Mr. Harwood near Clacton, remarking that the fact of this species presenting a macropterous form was apparently unrecorded hitherto.—Mr. W. J. Kaye exhibited *Nyssia hispidaria*, an asymmetrical specimen taken on Wimbledon Common.—Mr. C. O. Waterhouse exhibited a tube which formed the entrance to a nest of a *Trigona*, sent from Singapore by Mr. H. N. Ridley. He also exhibited a portion of the resinous mass formed within the trees by these bees, and stated that one of these masses sent from Penang by Mr. Ridley weighed 15 lbs. The true nest of the *Trigona* consists of an irregular mass of cells filled with honey, quite distinct from the resinous formation.—A paper was communicated by Mr. W. H. Ashmead, Assistant-Curator of the U.S. Nat. Hist. Museum, on "The aculeate hymenoptera of the Islands of St. Vincent and Grenada, with additions to the parasitic hymenoptera, and a list of the described hymenoptera of the West Indies."

Royal Microscopical Society, March 21.—Mr. A. D. Michael, Vice-President, in the chair.—A microscope presented by Mr. F. R. Dixon-Nuttall was referred to by Mr. Nelson, who said it was a microscope made by Benjamin Martin, dating about the year 1765. A solar projecting apparatus was packed in the same box; this was the invention of Dr. Lieberkühn, who brought it to London in 1740. Cuff improved it by adding the mirror in 1743. Mr. Nelson then called attention to a number of microscopes which had been sent for exhibition. The first noticed was by Plösel, and was kindly sent by Mr. C. L. Curties; this had already been illustrated in the *Journal*, but he asked the Fellows to inspect the coarse adjustment, which was very peculiar. The milled heads were of large diameter, a projecting stud was fitted on the inner side of each; from these studs descended a pair of links connecting them to similar studs fitted on to the sides of the body of the microscope; on turning the milled heads the studs moved through an arc and thus raised or lowered the body of the instrument. The next five microscopes were sent for exhibition by Messrs. Spiers and Pond. One, a French model, had a push-tube coarse adjustment and a short lever nose-piece fine adjustment. A vertical slot was made in the outer tube or sleeve to allow the fine adjustment to move up and down when the coarse adjustment was being effected. Another and smaller instrument was fitted with a simple mechanical coarse adjustment, which appeared to be a modification of the Plösel adjustment just described. The connecting links of the latter form were omitted; radial slots in the milled heads engaged the stud pins fitted on the sides of the body, so that when the milled heads were turned through a part of a circle the body was raised or lowered. In a yet smaller microscope there was an ingenious detail of construction in the method of securing the outer tube to the limb, by inserting the screws from the inside of the tube and screwing into the limb, a much superior plan to that of putting them in from the other side. There was likewise a diminutive microscope measuring about three inches high, of a cheap type. The next microscope was sent by Mr. Ernest Barker; it was a pocket form, the case measuring, when closed, $4\frac{1}{2}'' \times 2'' \times 1\frac{3}{4}''$. It was an ingeniously arranged little instrument, and very suitable for field work.—Mr. Nelson read an extract, sent by Mr. Jerome Harrison, of Birmingham, from Dr. Hooke's "Microscopium" (1678), describing a method of using convex lenses ("globules") by contact with water. Mr. Nelson thought it interesting to know that the immersion objective was not such a modern invention as was generally supposed. The chairman said this was a very interesting record, showing once more that there is nothing new under the sun. Mr. Nelson said Mr. Powell had just pointed out to him that these lenses of Hooke's differed from the immersion objectives of the present day, which had flat fronts, whereas in Hooke's lenses the water was applied to a convex surface, and so formed a sort of concave lens which corrected to some extent the chromatism of the glass.—Messrs. Swift exhibited a new pattern microscope, the upper portion of which was a replica of the Continental form, while the lower part was of the English type. The vertical axis was thrown more forward than usual, to admit of a larger stage being fitted.—Mr. Rousselet read a note in reference to a large selection of slides of new, rare and foreign rotifera which was exhibited under about thirty microscopes. Special reference was made to specimens of *Trochosphaera solstitialis*, *Apsilus lentiformis* and *Asplanchna herricki* which is much like other species of Asplanchna in shape, but possesses a small glandular organ with the tube opening outward, which is not known to occur in any other rotifer, and the function of which is quite unknown. In addition to this collection there were two specially well-mounted slides of Stephanoceros and Floscularia to show what can be accomplished in the way of preserving rotifers.

Geological Society, March 21.—H. W. Monckton, Vice-President, in the chair.—On a bird from the Stonesfield slate, by Prof. H. G. Seeley, F.R.S. The varied affinities of this large Carinate bird appear to lie midway between the ducks and geese on the one side, and the herons and flamingos on the other. It may be placed in a new family; but its characters are in all respects such as might have occurred in an existing bird. There is no indication of affinity to the *Archaeopteryx*, or that the bird diverged in any way from modern types.—The Lower Ludlow formation and its graptolite fauna, by Miss Ethel M. R. Wood. After dealing with the literature of the stratigraphical and palæontological sides of the subject, the author passes to a full consideration of the sequence and character of the Ludlow rocks in the following localities:—The Ludlow district, the Builth district, the Long Mountain; and gives a briefer account of those of the Dee valley, the Lake district, Southern Scotland, Dudley, and the Abberley Hills While the Wenlock shales are characterised by *Cyrtograptus* and by the *Flemingii*-type of *Monograptus*, in the Lower Ludlow shales the *colonus*- and spinose forms of *Monograptus*, such as *M. chimaera*, are abundant. The line between Lower and Upper Ludlow is drawn at the top of the Aymestry limestone. The Lower Ludlow rocks are divided into five graptolitic zones, which are not constant in character or thickness in the different areas.

Anthropological Institute, March 27.—Mr. C H. Read, President, in the chair.—A discussion of "Native life and customs in Sarawak" was opened by Prof. A. C. Haddon, who exhibited a series of lantern-slides, made from photographs taken by members of the recent Cambridge Anthropological Expedition. The earlier ones illustrated the river scenery of the Baram district of Sarawak, and the way in which travel is accomplished in that region, while the remainder were mainly concerned with the domestic life of the natives. All the houses, as was shown in the photographs, are built on the banks of rivers, and are of great size, a village usually being composed of a single house or of a long string of intercommunicating houses. These are built on posts, 10 ft. or 15 ft. in height, and each consists of a long verandah in which is centred nearly all the social life of the community. Hanging from its rafters are usually trophies of skulls of the inhabitants' enemies; under the skulls a fire is kept burning and many sacred objects are associated with them, including stone implements which are handed down from father to son, and in some cases are looked upon as the teeth and toe-nails of the Thunder God. The verandah is often decorated with carvings and painted boards, and ornamentation of various kinds, according to the artistic genius of each tribe, is found on the implements and objects of every-day use. A partition, which runs the whole length of the building, separates the verandah from the dwelling-places of the various families, each of which inhabits a private set of rooms opening by one door into the verandah. Outside the houses are wooden images, posts, and sacred stones at which offerings are made on important occasions. The occupations of the natives were also illustrated.—Mr. C. Hose, resident of Baram, Sarawak, also showed some slides, and said, in reply to a question based upon the statements of Bock and other travellers, that cannibalism existed in Borneo, that there were cases in which human flesh was eaten, but he did not think they could be properly called cannibalism. Sometimes they cut off strips of flesh from their enemies, but these were not eaten, as some observers had too hastily concluded. On the contrary, they were stored in bamboos and used as an offering to the hawks from which the omens were taken. The occasions on which human flesh was eaten were cases of chronic illness in which a small piece, swallowed with great difficulty by the patient, was supposed to be curative. In Dutch Borneo the people did roast and eat human flesh, but only very rarely, and the practice had been stopped by the Dutch. When a male child about fourteen years old was very ill, it was thought proper to keep him alive, if possible, at the expense of a female life, which was less valuable; hence, as a last chance of saving his life, a sister would be sacrificed, and a small piece of the flesh given to the boy to eat. A large part of Mr. Hose's

valuable collection of native objects from Baram was exhibited during the evening.—At the forthcoming meeting, Tuesday, April 24, Prof. Haddon will give a similar account of the researches of the Cambridge Expedition in Torres Strait, and Dr. Rivers will describe his genealogical method of collecting social and vital statistics, which was applied with success in the same district.

Zoological Society, April 3.—Prof. G. B. Howes, F.R.S., Vice-President, in the chair.—Mr. G. E. H. Barrett-Hamilton contributed a paper, entitled "Notes on *Mus sylvaticus* and its Allies, Subspecies and Geographical Variations."—A communication was read from Mr. Stanley S. Flower containing an account of the Mammals of Siam and the Malay Peninsula.—Mr. A. Smith Woodward communicated a paper, by Dr. Einar Lönnberg, on a piece of skin found along with the remains of *Grypotherium* in Cueva Eberhardt, Patagonia. A detailed description and comparison of the specimen led to the belief that it belonged to the extinct horse—*Onohippidium*. Dr. W. G. Ridewood added a note on the structure of the hair bordering two equine hoofs, probably fœtal, found in the same cave by the La Plata Museum expedition. The hair agreed in most respects with that described by Dr. Lönnberg, and thus seemed to confirm his determination.—Mr. C. Warburton exhibited and described a remarkable new Attid Spider (*Mantisatta trucidans*), the chief characteristic of which was the possession of predaceous front legs, the spines being so arranged as to form a prehensile weapon. It had been taken in Borneo.

Mineralogical Society, April 3.—Prof. G. D. Liveing, F.R.S., Vice-President, in the chair.—Prof. W. J. Lewis showed the application of Grassmann's method to the calculation of the angle between two poles.—Mr. R. W. H. T. Hudson gave a solution of the problem to determine the position of points and planes after a rotation through a definite angle about a known axis.—Mr. L. Fletcher described the methods employed in the chemical analysis of the Mount Zomba meteorite.—Dr. A. Hutchinson gave the results of a determination of the refractive indices of chalybite and diallogite.—Mr. G. T. Prior pointed out the close crystallographic relationship between hamlinite, florencite, beudantite and svanbergite, and showed that in chemical composition these minerals, together with plumbogummite (hitchcockite), all conform to formulæ analogous to that of hamlinite if, in the case of beudantite and svanbergite, one molecule of P_2O_5 be regarded as replaced by two molecules of SO_3, *i.e.* by S_2O_6; in conformity with this result the alkaline earth in svanbergite was found to be strontia and not lime.—Mr. Prior also contributed a paper on Ægyrine- (and Riebeckite) -Anorthoclase rocks from near Adowa, Abyssinia, which form a series strictly analogous to Brögger's "Grorudite-Tinguaite" series of the Christiania district, the more acid group containing quartz, and the more basic, nepheline.—Prof. H. A. Miers exhibited specimens of anatase and brookite from Tremadoc.

Mathematical Society, April 5.—Lieut.-Colonel Cunningham, R.E., V.P., in the chair.—The following communications were made:—On the addition theorem for the Bessel functions, by Mr. H. M. Macdonald.—The orthopticloci of curves of a given class, by Mr. A. B. Basset, F.R.S.—The uniform convergence of Fourier's Series, by Prof. Love, F.R.S.—Extension of orthogonal and Boolian co-variants, by Major MacMahon, F.R.S.—A paper was also received from Mr. Bromwich, entitled "On Weierstrass's canonical reduction of a 'schaar' of bilinear forms."—The chairman announced that the May meeting would be made "special," in accordance with a resolution already made known to members.

MANCHESTER.

Literary and Philosophical Society, April 3.—Prof. Horace Lamb, F.R.S., President, in the chair.—A paper on "Aërial Locomotion" was read by Mr. Henry Wilde, F.R.S.

EDINBURGH.

Royal Society, March 19.—Lord Kelvin, President, in the chair.—Dr. Thomas Muir communicated three papers: (1) A development of a Pfaffian having a vacant minor; (2) the theory of alternants in the historical order of its development up to 1841; (3) Jacobi's expansion for the difference-product, when the number of elements is even. In the first paper, the expansion was obtained as a sum of partial products, each of which was a minor determinant multiplied by the complementary minor Pfaffian of the original Pfaffian; and the third paper contained a proof of Jacobi's rule for expanding the difference-product $\zeta_{\frac{1}{2}}(a, b, c \ldots)$ as a series of partial products, each of which is a Permanent multiplied by a Pfaffian.—Dr. A. Galt read a paper on the heat of combination of metals in the formation of alloys, completing the work of previous papers on the same subject. It was shown that, in the formation of copper and zinc alloys, the heat of combination was negative for small percentages of copper; then, as the amount of copper was increased, it became positive, and obtained a maximum when the percentage of copper was about 38. For higher percentages of copper the value of the heat of combination gradually fell off to zero.

PARIS.

Academy of Sciences, April 2.—M. Maurice Lévy in the chair.—On a new gaseous body, sulphur perfluoride, by MM. H. Moissan and P. Lebeau. By the action of fluorine upon sulphur two fluorides of sulphur are produced, only one of which is absorbed by potash. The unabsorbed gas, which is very stable towards chemical reagents, has the composition SF_6.—On the origin of the fossil trunks in the coal-measures, by M. Grand' Eury. From a study of the positions in the coal-measures in which *Cal. cannoeformis*, *Arthropitus* and *Calamodendron* occur, the author concludes that there can be no doubt that these Calamites are not in the position in which they originally grew, as is proved by the numerous adventitious roots surrounding the stems.—Report on a memoir of M. Torres, entitled "Calculating Machines." The paper gives a complete theoretical solution of the problem of constructing algebraical or transcendental functions by machines. There is also an account of a machine actually constructed for the solution of certain types of algebraical equations of which frequent use is made.—Prof. Van der Waals was elected a Correspondant in the Section of Physics in the place of Sir G. G. Stokes, elected Foreign Associate.—Remarks on the criterium of Tisserand, by M. Gouey. A discussion of a theorem given by Tisserand to decide if two different orbits given by observation may or may not belong to the same comet, owing to the effect of attraction of a planet.—On differential equations of the third order with fixed critical points, by M. Paul Painleve.—On an inversion of a double integral, by M. J. Le Roux.—On the geometrical applications of Abel's theorem, by M. Ch. Michel.—On a machine for solving equations, by M. Georges Meslin. The machine consists of a balance carrying upon its beams at varying distances from the point of support a series of solids of revolution, partially immersed in a liquid. If the depth immersed is x, the forces exercised upon the solids are represented by x^m, $x^{m'}$, $x^{m''}$; they act at distances p, p', p'', and there is the force A acting at unit distance. Hence x satisfies the equation

$$px^m + p'x^{m'} + \ldots + p''x^{m''} = A,$$

and the height x will be the solution of the equation. The solution of the equation $5x^3 - 4x^2 - 7x = A$ is worked out as an example.—On the property of certain bodies of losing their phosphorescence by heat, and of recovering it on cooling, by M. Gustave le Bon. Some radio-active barium chloride was found to lose its power of phosphorescing at 200°, but to regain it on cooling. Quinine sulphate was found to behave in a similar manner.—Velocity of propagation of electro-magnetic waves in bitumen, and in bitumen-covered wires, by M. C. Gutton. It was found experimentally that in bitumen the electro-magnetic waves are propagated with the same velocity, whether they are guided by wires or not.—On the production of electrostatic images in sensitised plates, by M. W. Schaffers. The results obtained are of interest from the point of view of the exploration of an electric field.—On the influence of iron on the discharge of a condenser through an induction coil, by M. G. A. Hemsalech. The introduction of the iron diminishes, and finally destroys, the oscillatory character of the current, the changes being readily studied by the appearance of a Geissler tube placed in the circuit. The effect of the iron is analogous to that produced by the introduction of a large resistance.—On some optical peculiarities of Geissler tubes under the influence of a magnetic field, by MM. N. Egoroff and W. Georgiewsky.—The use of new radio-conductors for telegraphy without wires, by M. C. Tissot. The Branly tube is placed in a magnetic field, the lines of force of which are parallel to the axis of the tube, the powder being composed of some magnetic substance—steel, nickel or cobalt. The sensibility of the apparatus is thus greatly increased,

messages being readily received from a station 30 kilometres distant, and at the same time the regulation and adjustment of the tube is rendered much more simple.—The auto-cohesion of charcoal, and on the application of this discovery to telephonic apparatus for receiving the signals in wireless telegraphy, by M. Thomas Tommasina. A description of an instrument for receiving the Hertzian waves by means of a telephone. The apparatus is very sensitive, and works quite regularly even with such a strong current as three accumulators in series.—On a new radio-active element, actinium, by M. A. Debierne. The new element is obtained from the residues of pitchblende, and, except for its radio-activity, behaves as an impure thorium salt.—Solubility of a mixture of salts having a common ion, by M. Charles Touren. An experimental study from the Nernst point of view of the solubility of mixtures of potassium chloride and nitrate, and of potassium bromide and nitrate, the results being given graphically.—Action of hydrogen upon antimony sulphide, by M. H. Pelabon. The interaction of hydrogen and sulphide of antimony in sealed tubes at 440° showed that the composition of the gaseous mixture, hydrogen sulphide and hydrogen, was constant and independent of the amount of solid sulphide or of antimony present. At 625° the results were similar, and the inverse reaction of hydrogen sulphide upon antimony reached practically the same equilibrium.—On an arsenide of nickel, by MM. Albert Granger and Gaston Didier. Reduced nickel heated in a current of carbon dioxide carrying the vapours of arsenic trichloride gives an arsenide, Ni_3As_2.—On the biphosphide of tungsten, by M. Ed. Defacqz. By the action of dry hydrogen phosphide upon tungsten hexachloride at 450° C. a new compound, WP_2, is obtained, the properties of which are given. A chlorophosphide, a double phosphide, and another new phosphide were obtained from this.—On a new terpenic alcohol and its derivatives, by M. P. Genvresse. The new alcohol, pinenol, $C_{10}H_{16}O$, is obtained by the action of nitrous vapours upon pinene or essence of turpentine. A new oxime, pineononoxime, is obtained at the same time, the ketone corresponding to which is readily obtained by the oxidation with chromic acid of the pinenol.—Action of phenyl isocyanate and isothiocyanate upon the dibasic acids, by M. Élophe Bénech. The Haller reaction is a general one, and allows of the preparation of azelaic dianilide; phenyl isothiocyanate behaves like the isocyanate with fatty dibasic acids, with the exception of the malonic acids.—Influence of an active vegetation upon the formation of thuyone and thuyol, by M. Eugène Charabot.—Considerations on the differences which exist between the fauna of the Opistobranchia of the ocean coasts of France and of the Mediterranean coasts, by M. A. Vayssière.—On the zoological affinities of the Phoronidia and Nemertinæ, by M. Louis Roule.—On the embryonic development of the Cestodia, by M. G. Saint-Remy.—Sounding and analysis of the sediment of Lake Galescu in the Southern Carpathians, by MM. de Martonne and Munteanu Murgoci.—On the strata near Bray, by M. Munier-Chalmas.—Contribution to the study of the antileucocytic serums and their action on the coagulation of the blood, by M. C. Delezenne.—On the fixation of alkaline bases in the mineral skeleton of the human fœtus during the last five months of pregnancy, by M. L. Hugounenq. An analysis of the changes in the ratio of soda to potash in the mineral skeleton of the fœtus from the fourth to the ninth month.—On the physiological properties of nitriles, by M. Edmond Fiquet. An experimental study of the toxic effects of injections of acetonitrile, sodium cyanacetate, cinnamic nitrile, and sodium α-cyanocinnamate.—Variations in the amount of iodine present in the thyroid gland of the newly-born under divers pathological influences, by MM. Charrin and Bourcet.—Experimental reproduction of caries of the teeth, by M. J. Choquet.—On a new pathogenic microbe in the rabbit, *Bacillus myophagus cuniculi*, by M. C. Phisalix. The bacillus is found in a rare disease of the rabbit, chiefly affecting the muscles.—Heterotopic differentiation. The teratological process, by M. Étienne Rabaud.—Therapeutic action of the acid phosphoglycerides, by M. G. Bardet.

AMSTERDAM.

Royal Academy of Sciences, February 24.—Prof. H. G. Van de Sande Bakhuyzen in the chair.—Prof. Van Wijhe read a paper on a simple and quick method of preparing picrocarmine.—Prof. W. H. Julius read a paper on solar phenomena considered in connection with anomalous dispersion of light.—The following papers were presented for publication in the *Proceedings*:—Entropy of radiation (ii.), by Mr. J. D. van der Waals, jun.—A paper on the formation of trisubstituents of benzol from disubstituents, by Prof. A. F. Holleman.—Enantiotropy of tin (iv.), by Dr. Ernst Cohen.—Inquiries into the system $TlNO_3 + AgNO_3$, by Dr. C. van Eyk. Melted mixtures of the two salts successively deposit: rhombohedral and then rhombic $TlNO_3$ on the $TlNO_3$ side, and rhombohedral and then rhombic $AgNO_3$ on the $AgNO_3$ side, while out of the mixtures of 48–52 mol. per cent. the double salt $AgNO_3$ is deposited, which melts at 83°. Below 27° this salt undergoes a change, either by passing into another modification or by splitting up into its components.—Rational curves in space, by Prof. Schoute.

DIARY OF SOCIETIES.

WEDNESDAY, APRIL 18.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Demonstration on the Structure of some Palæozoic Plants, with Sections of the Plants thrown on the Screen: Wm. Carruthers, F.R.S.

THURSDAY, APRIL 19.

LINNEAN SOCIETY, at 8.—Alpine Vegetation of Tibet and the Andes: W. Botting Hemsley, F.R.S., and H. H. W. Pearson.—On some Mosses from China and Japan: E. S. Salmon.

FRIDAY, APRIL 20.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

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